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Steel Rib Reinforcement in a Concrete Bridge

Two Committees Report on the Knickerbocker Theater Collapse

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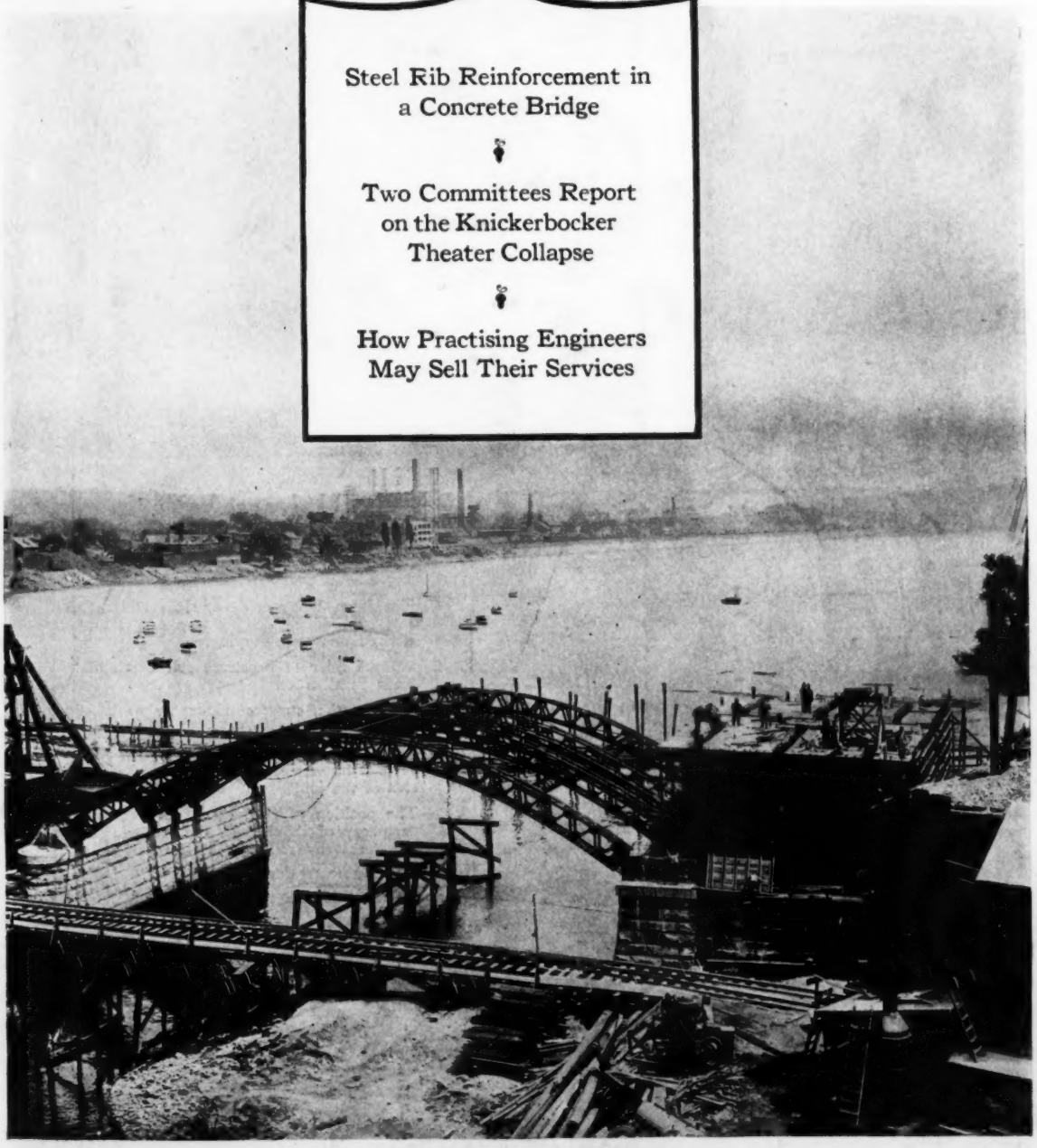

Steel Reinforcing Ribs In Place
In One of the Arches of the Springfield Bridge
Across the Connecticut

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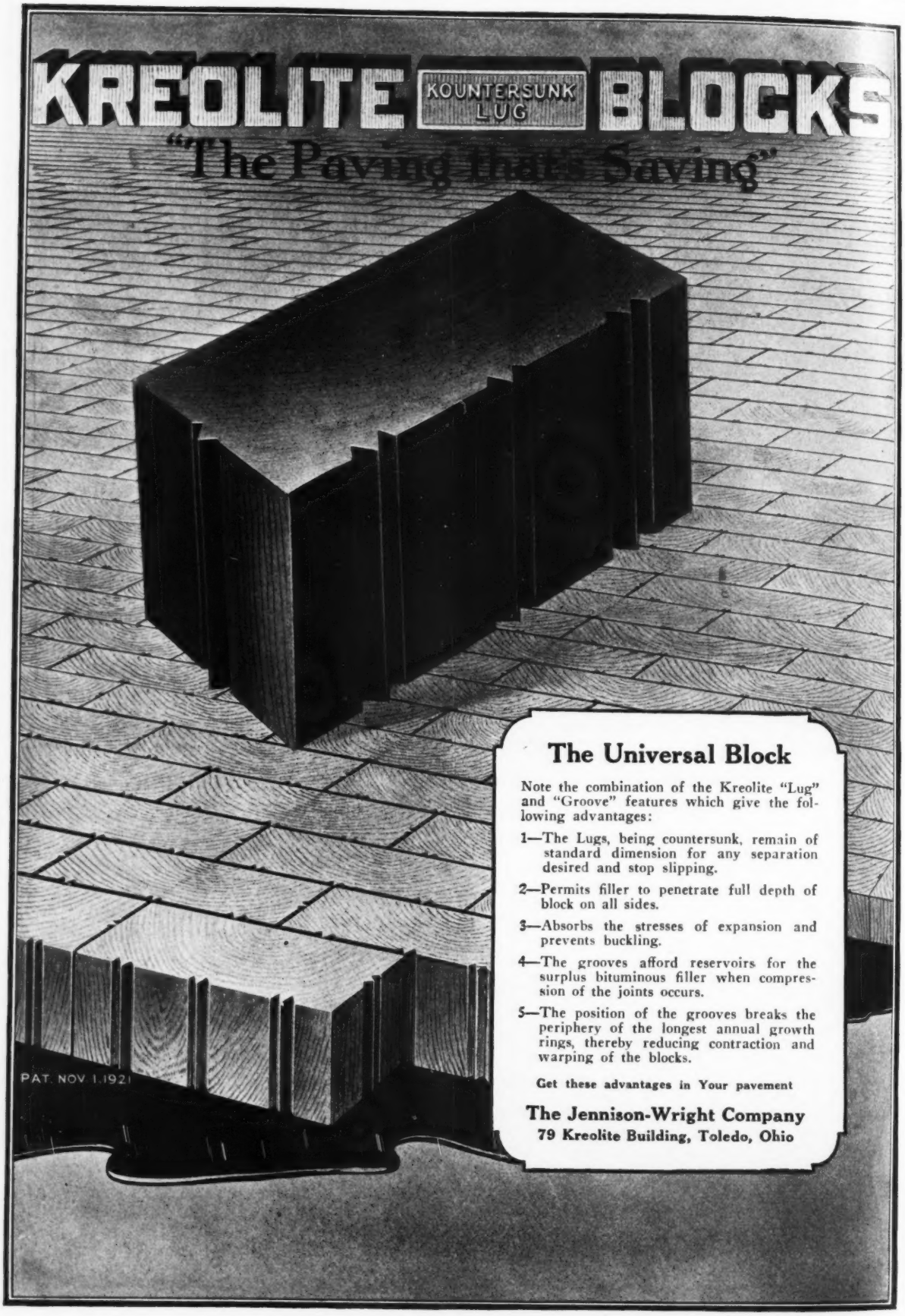

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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 88 — NEW YORK, MARCH 30, 1922 — Number 13

Wise Water-Supply Policy

IN GRANTING Bayonne the right to divert 50 m.g.d. from the Ramapo River for municipal water supply, the New Jersey Department of Conservation and Development, on March 23, made provisos (1) to guard the interests of other communities which have had an eye to this source of supply and (2) to facilitate the complete development of the Passaic and its tributaries under one of the projects outlined in the Hazen report abstracted in our issue of March 16. These provisos require Bayonne to develop not less than two-thirds the maximum yield of the stream by 1919 and all the yield when demanded by the department; the supply of Ramapo water by Bayonne to communities desiring it, after approval by the department, on terms to be agreed on mutually or, in default of agreement, to be fixed by the department; and the surrender by Bayonne, at a fair price, of the Ramapo grant to any board or commission having authority to acquire and consolidate existing public water supplies. These requirements, modified if and as needed to meet local conditions, might well be followed in other densely populated states where there is rivalry for sources of water supply and likelihood of a future need for a joint water undertaking for a water district, metropolitan or even less extensive.

France Gives Up Railroading

WORD has recently come from the other side announcing that after fourteen years' experience the French Government is planning to abandon the operation of the Etat Railway System and to turn over the property to a private corporation. Government operation of this line we learn has been not only bad business for the taxpayers but also quite unsatisfactory from the viewpoint of the railroad users. In view of our own national experiments, it is interesting to observe that after a long trial, part of which was under normal business conditions, France, too, has come to the conclusion that "government in business" is good neither for government nor for business.

Service to the Profession

A FINE service has been rendered to the engineering and architectural professions by the two investigating boards whose findings concerning the Knickerbocker Theater roof collapse are summarized in this issue. What they have accomplished in clearing up the disquieting puzzle will find acknowledgment, we think, in feelings of satisfaction and relief on the part of every one connected with the building art. Full appreciation of the service rendered may perhaps come only with time; the searching inquiries, going to the root of the evil of bad construction, will surely have a sanative effect, but one of gradual development rather than immediate. Every forward-looking member of either profession owes the men composing the two boards a tribute of thanks. They labored for him. The killing of a hundred citizens put a challenging question to us all, not merely to the small professional group in Washington. But because they were nearest to hand, they took up the burden of answering the question. Their self-assumed obligation—and we speak more particularly of the American Association of Engineers' committee— was discharged under great difficulties. Moreover, they brought to bear on their task a keenness of observation, a depth of insight, and a breadth and soundness of judgment that would themselves compel praise and warm appreciation. What was accomplished by the two investigating bodies sets a brilliant precedent for future professional service.

Results of Neglect

ALL mystery has been removed from the collapse by the studies of the investigating boards. There were no new agencies of danger, but only the old and too familiar one of bad work—the product of progressive neglect. The structure was not a building; architecturally it may claim the name, but never structurally. It was a reckless assemblage of building-code walls, unstable roof framing, and a concrete slab covering that was a credit to the materials of which it was made but not to the men who used them. Despite the wall and slab construction, however, it appears that the steel roof frame, after all, was the focal point of trouble. The steelwork was unsound in its general conception and inexcusably bad in its details. Important teachings are to be found in its individual defects: in the fatal weakness of the gusset plates, a subject demanding much more research study that it has yet received; in the equally fatal overloading of the thin and unstayed chord end, whose part in the outcome appears to be rather under-emphasized; in the absence of anchorage and bracing, and in the inadequacy and bad detailing of the columns, which yet by some miracle did not fail. However, the most significant feature of the case, as indeed of many prior failures, is that not one defect alone but half a dozen or more might and should have been the cause of destruction. The roof was condemned by all its parts rather than by a single one; and such a condition may be recognized as the product of thoroughgoing, cumulative neglect. Slighting one after another of the principles of sound practice, taking a chance with one bit of poor detailing and then with another, leaves in the end only a husk and shell of designing and detailing, a mockery of engineering.

Architectural Responsibility

ULTIMATELY a single brain and conscience, the personality of one man, stands back of any structure and guarantees its safety. The architect is that man in the case of buildings. Does he, in fact, assume and fully discharge this responsibility, or is it merely

a matter of form? That is the outstanding query resulting from the Knickerbocker disaster, and it is squarely up to the architectural profession to answer it. If the architect's creative responsibility, and the associated guarantee of adequate construction, is a mere historic form, without substance, it is time that the facts were known to all the world and time that other means to guard public safety be provided. If the responsibility is still to be regarded as real, it is time that steps were taken to make it real. The point at issue is a condition such as found in the Knickerbocker case—and such conditions, it must be admitted, are far from uncommon—where the architect gives careful attention to the externals, the appearance of his structure, but depends for the vital matter of making the structure safe upon an interested party, namely, a sub-contractor, without even an attempt to check the result. If the responsibility for the safety of a building may be thus divided and farmed out, what is left of the personal and competent answerability of the architect for his structure? What is left of the architect? The practices and laws requiring buildings to be planned by architects, and all plans to be duly accredited by his signature, have been regarded by the public as an assurance of safety. It is no assurance of any kind, however, unless the architect definitely assumes the responsibility implied, and shapes his practice so that his guarantee is real and not a sham.

Railroading as an Engineering Career

AT THE railway engineering meeting in Chicago week before last, there was discussion of the lack of attractiveness of a railroad career to young engineers. To impartial observers of railway engineering organizations nothing new developed in this discussion, other than the fact that ranking officials of these organizations have come to recognize, or at least to admit, what has long been generally appreciated. The wonder to the impartial observer is that as the key positions needed filling men of sufficient mold were available; in fact, despite the eminence displayed in the top ranks today, there has been a shortage of first-class men. Doubtless this shortage has impressed itself on the chiefs. However, the condition was plainly foretold years ago. The glamour of railroading began to fall off some fifteen years ago; at least, as far back as that the prospective graduates said that pay was poor and promotion in responsibility slow. They, therefore, began to avoid railroad work.

For this unfavorable attitude the engineering department heads have largely themselves to blame. Mr. Stocker, in saying that the older engineers do not take a helpful attitude toward the beginners in the service, voices the common impression of the young men. They have felt that the department heads were unappreciative of faithful service and hard work. There was neither commendation nor salary increases as evidence.

The cure is a more careful regard by the leaders for the upbuilding of their organization. Railroad careers must be made attractive if strong young men are to be invited and held.

All traces of the martinet influence of the days when a youngster was told that his time was the railroad's for 24 hours out of every day, and when the ordering of almost superhuman stunts was considered one of the necessities of railroading, have to go by the board. Not that young men need pampering. They do not. They will still give as loyally as their predecessors of a generation ago when occasion demands—even to nerve-racking vigils and superhuman efforts. But the opportunities have changed. Thirty years ago railroading was almost the dominant civil-engineering activity. Today it must compete with many attractive careers open to the young civil engineer.

For the sake of the transportation of the future railroading as a career must be rehabilitated in the minds of young engineers, and the rehabilitation rests upon the chiefs setting right standards of pay and so organizing that the strong men are discovered, recognized and rewarded.

An Opportunity for Trade Associations

THERE should be widespread response to the invitation of the Secretary of Commerce to trade associations to meet with him April 12 in order to arrange for the clearing of statistical material through the Department of Commerce. Such a conference is the inevitable result of the correspondence between the Secretary and the Attorney-General, in which the latter held that there was no violation of law if trade statistics gathered by associations were disseminated by the Department of Commerce and made available simultaneously to the members of the associations and to buyers. It should be noted that the essential feature of this method of dissemination is not the functioning of the Department of Commerce, but the simultaneous sharing in data by consumer and producer. The department merely furnishes an easy means for the accomplishing of the result.

It is going to take some wrenching of hitherto held notions for the trade associations to accept this simultaneous sharing of production, stock and shipment figures with the public. It is clearly indicated by the public temper, though, that this is the price which the public proposes to exact for the privilege of allowing the collection of statistics at all. As we have previously said in these columns, the confining of statistics to the membership may be legal, but certainly the easy way out, the way that will commend itself to the public, is through free publication of the association-gathered data.

Nor do we fear the dire results which some producers have predicted, such as unsettlement of the market and unintelligent buying due to the inability of the public to interpret the statistics properly. In the beginning there may be misinterpretation, but the public will soon learn how to translate them properly. Then there will ensue more intelligent buying, with consequent satisfaction.

Not to be neglected, either, will be the removal of the suspicions now entertained toward trade associations because of their statistical activities. As a corollary is the confidence that will ensue from the knowledge that the association has not available confidential information that may allow it to take advantage of the public.

As we see it, therefore, a good result from the meeting of April 12 will be of as great value to the associations as to the public. It is to be hoped that the associations will come there in large numbers impressed with that point of view and determined to square their functioning with the temper of the public.

Long-Term Road Bonds Again

SO OFTEN has the danger signal been raised against bonds whose terms extended beyond the life of the improvements for which they are issued that there is little excuse, at this date, for ignorance of the economic fallacies involved in such practice. It is a good many years since this journal published its first editorial condemnation of the long-term bond for the short-lived road. Competent banking authorities have gone so far as to oppose the general principle of bond issues for public improvements except in cases where they cannot be avoided, preference being given to the raising of money for such purposes by tax levies. Massachusetts began raising funds for road building by the issuance of 30-year bonds. This policy was pursued until 1913, when the 15-year serial bond was adopted. Beginning in 1919, however, the state ceased issuing bonds for highway purposes and the money has since been taken from current revenue.

If the financing is to be done by bond issues, two important factors to be considered are the character of the improvement and the total cost to state, county, or township. Sound policies of finance demand that indebtedness for road-building be liquidated at a rate at least equivalent to the depreciation of the improvement financed. In Florida, recently, certain county road work has been financed by the issue of 30-year serial bonds. While motor traffic in that section of the country may be lighter than elsewhere, it is fairly safe to assume that at the date of maturity of the 30-year bonds little, if anything, will remain of the pavements now being constructed. The long-term bond, while it involves lower yearly carrying charges, is, in the end, an expensive luxury. For the sake of comparison the following figures show the average annual cost and the total cost of a $100,000 serial-bond issue at 5 per cent.

Term in Years	Av. Annual Cost	Total Cost	Term in Years	Av. Annual Cost	Total Cost
5	$23,000	$115,000	20	7,625	152,500
10	12,750	127,500	25	6,600	165,000
15	9,333	140,000	30	5,917	177,500

These figures are well worth study. They show, for example, that with a 30-year bond issue as against one of 10 years, the saving in total cost amounts to exactly half the face value of the bonds.

Some of the states have recognized the fallacy of the long-term bond for road-building work. In New Jersey, for instance, specific limitations are placed on the terms of bonds according to the type of the improvement, as follows: Bridges, 30 years; concrete roads (6 in. thick), block pavements or asphalt on concrete foundations, 20 years; bituminous concrete, 15 years; macadam with bituminous surface, 10 years; gravel, 5 years.

It would be proper, of course, to consider that certain elements in a new road have a life much longer than that of the surfacing—the culverts for example—while certain other elements are almost permanent improvements. In the latter class come grading, new alignment, and the underdrainage. On these a longer bond term would be justified on the mere basis of the life of the improvement. Here, however, would properly enter considerations of higher total cost of the longer issues.

With public sentiment at present decidedly in favor of the good-roads movement it is not difficult to secure approval for ill-advised schemes of highway financing. Those in responsible charge of financing policies, however, have an obligation to protect the public against extravagant and uneconomic expenditures for bond issues extending beyond the life of the improvement which the obligations cover.

Self-Supported Arch Reinforcement

STRUCTURAL steel reinforcement for concrete bridges is not new. The earliest type of concrete arch introduced into this country was that devised by Melan, in which the steel was of small shapes framed and placed in vertical planes in a barrel arch. A self-supporting steel frame, erected as an arch and acting first to support the concrete of the arch without additional centering and later as a partner with the concrete to take the working stresses in the ribs—this is quite different from the Melan bridge, in which the steel served only as reinforcement. This self-supported type was early recognized as offering many advantages, notably in the reduction of centering costs, but it has never been very popular, probably because of the possible break in adhesion between concrete and the wide flat surfaces of structural steel and the doubtful distribution of the stresses between the proportionately large steel section and its enveloping concrete.

The former danger was quite clearly shown in the failure of the Third Street bridge at Dayton, an early Melan arch, which was found to have well defined cleavage planes along the rusting steel frames of the reinforcement. The latter doubt arises from the fact that in the usual reinforced-concrete arch, so called, the steel has little but an emergency value, to take care of the tension that may possibly develop from some unexpected loads which cause the line of thrust to fall outside the middle third. A composite concrete and steel structure with a complete interaction of both materials under all conditions presents quite a different problem, and one which has not been too well analyzed or subjected to test.

The Springfield bridge, described on another page, is the latest development of the self-supported steel type. In it the steel frame admirably serves as a centering, with consequent economy and safety in a river subject to rapid rises. But it is more than reinforcement; it is the major part of the arch section and its disposition and chronology of erection makes it possible to develop in the steel the full proportion of the ratio of elasticity of the two materials. The justification of such a type lies in comparative analysis of cost, assuming, of course, that considerations of appearance, maintenance and wear bar the uncovered steel arch or even the steel arch with a light covering of concrete not assumed to carry stress. Such an analysis governed the design of the Springfield bridge, but it was also considered to have superior qualities in the exact determination of the thrust line through the hinges and in ease of erection.

The possibility of a future reduction of adhesion still remains, but such a danger is much less in a rib arch than in a barrel arch cut at frequent intervals by the vertical planes of the ribs. Transverse or torsional action in an earth-loaded barrel might well set up strains between concrete and steel which would never occur in a comparatively narrow rib loaded from columns at intervals, and hinged at its abutments.

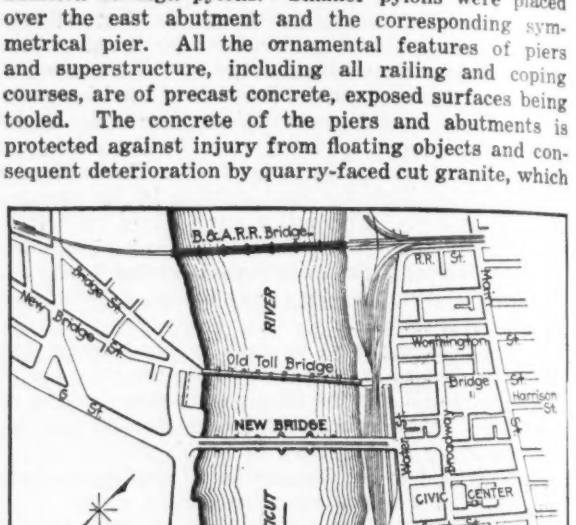
The Springfield bridge design is not unique but it is sufficiently novel to make it worthy of attention. Designers of similar large structures may well make the comparative analysis of the conventional type with this development before deciding upon their new bridges.

Steel Rib Reinforcement Used for Concrete Arch Centers

Monumental Concrete Bridge Across Connecticut River at Springfield, Mass.—Saves Cost of Falsework—How the Stresses are Figured

THERE is now being built across the Connecticut River between Springfield and West Springfield, Mass., a monumental concrete highway bridge of considerable architectural distinction and with some exceptional features of design, notably the use of structural steel arch-rib reinforcement which serves as centering for the arch ribs during placing. The bridge was authorized in 1915 to supersede a century-old wooden structure, and a board of commissioners made an exhaustive report soon after. Controversy as to width and location, however, postponed authorization until about two years ago. Work was started in the summer of 1920 and the bridge should be opened to traffic next July. Its total cost, exclusive of land damages, will amount to about $4,000,000.

As shown on the drawing, the bridge connects the two separate communities of Springfield and West Springfield. It crosses the river practically at right angles and reaches Springfield on a high grade street above the railroad tracks, two blocks away from the principal street of the city, Main St., and also two blocks from the civic center. On the West Springfield side a new set of earth-fill approaches will have to be built connecting the bridge to existing streets. Earlier layouts had the bridge crossing diagonally from Bridge St. in West Springfield, at the west end of the old toll bridge, and entering Springfield on the axis of the civic center, which is a well planned development in the business section of that city.



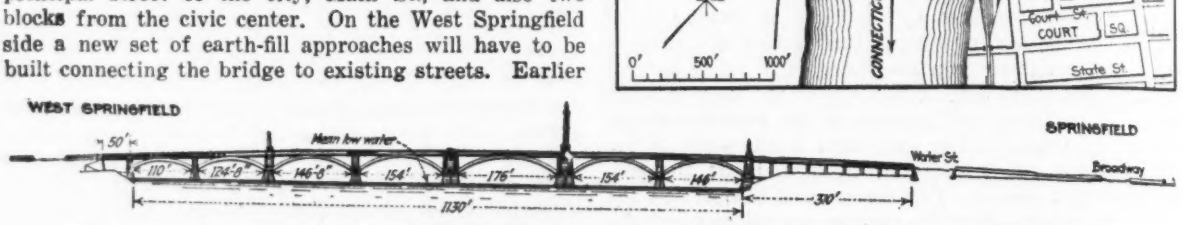


FIG. 1. PLAN AND ELEVATION OF NEW BRIDGE ACROSS CONNECTICUT RIVER AT SPRINGFIELD, MASS

The bridge consists of seven arch spans over the river, nine viaduct spans over the railroad tracks to the east, and earth-fill approaches extending about one-half mile to the west. The five easterly spans of the river bridge are symmetrical about the 176-ft. channel span, and the two westerly spans balance the viaduct spans at the easterly end. The total length of the bridge is 1,494 ft. and the length of the river bridge is 1,192 ft. The span lengths, as shown on the drawing, vary from 110 to 176 ft., and the rise of the arches from 19.1 to 29.7 ft. The bridge is 80 ft. between centers of concrete railings and carries a 60-ft. roadway and two 9½-ft. sidewalks. A clearance of over 40 ft. above mean low water for a width of 60 ft. was provided in the channel span, this clearance being in excess of that required by the War Department.

A requirement of the legislative act authorizing the bridge made it necessary to design and build the channel span so that it can be removed and a draw bridge substituted when and if required for navigation purposes. This latter condition required abutment piers for the center span and the architectural design was then centered around these piers, with the symmetrical spacing noted above, and furthermore with the embellishment of the large piers both by surface decoration and by the addition of high pylons. Smaller pylons were placed over the east abutment and the corresponding symmetrical pier. All the ornamental features of piers and superstructure, including all railing and coping courses, are of precast concrete, exposed surfaces being tooled. The concrete of the piers and abutments is protected against injury from floating objects and consequent deterioration by quarry-faced cut granite, which extends from a short distance below low water to the springing line of the arches.

Bedrock is not available at the site, so all foundations are on closely spaced wood piles. The piers, a section of a typical one of which is shown in Fig. 2, are of concrete placed inside cofferdams under water on top of the piles up to about 7 ft. below water, above which the concrete was placed in the dry. A feature of the design of the narrower piers is the use of 1-in. round rods extending from the top of the pier vertically down into the bottom section, where they are hooked for anchorage. These rods, which provide reinforcement for stresses caused by construction loadings, are shown in Fig. 2. The skewbacks on the piers are of cut granite placed on the piers to rough line and cut to the exact line after being set. It is stated that this special cutting required about 80 hours' work on each of the 70 skewbacks, but that it guaranteed an exact location of the steel arch ribs, and was therefore worth while. The channel piers shown in Fig. 2 have an open section in the middle for economy of weight and cost. This required a certain amount of reinforcing in the concrete over the opening. The piling and base of the east abutment are extended into the bank to carry two of the viaduct piers.

The arches themselves are made up of five ribs, three grouped near the middle and one at each side, as shown in the cross-section. This spacing is for equal distribution of loading, as described hereinafter. The reinforced-concrete roadway is carried on columns resting

on pedestals on the arch rib, with a solid concrete facing wall in the outer spandrel space. The arch ribs are parabolic, 4 ft. 6 in. wide, of constant depth in each span but varying in depth with the span lengths, and are when completed two-hinged, although they were built three hinged. They are reinforced with heavy structural steel lattice girders, erected as three-hinged arches with only a center support, except in four of the longer spans where supports at both center and quarter points were used. From the steelwork were then hung the forms in which the concrete of the arch ribs was placed, the hinges at the crown of the outside ribs being riveted before concrete was poured, and those at the springing line being left open. The adjustment of the steel ribs was secured by heavy screws through the cast-steel shoes, by which the distance between the face of the granite skewback and the base of the shoe could be varied. After adjustment, this space was filled with an alloy of antimony and lead which does not shrink on cooling.

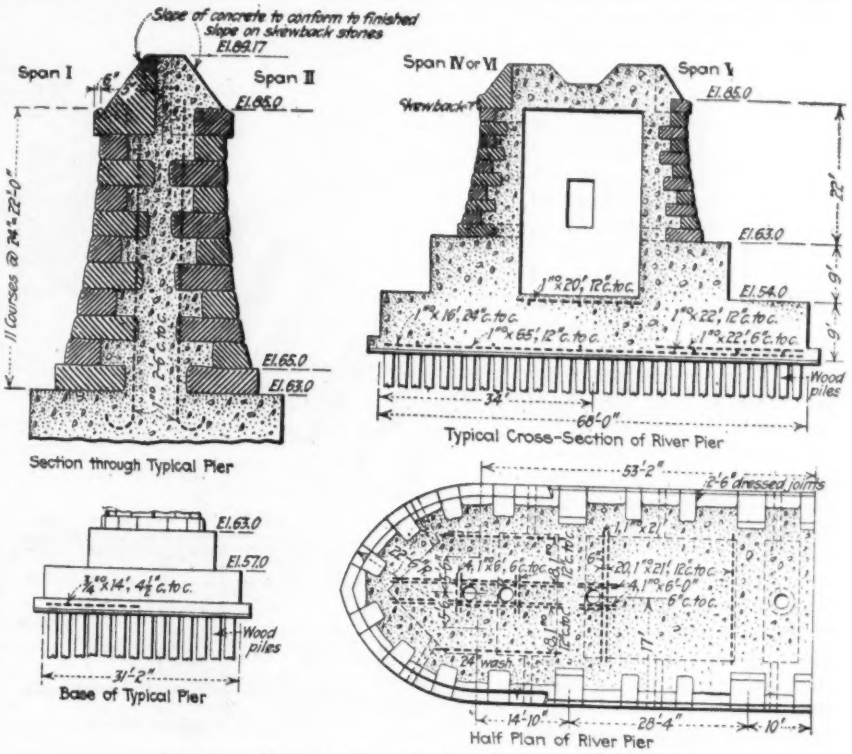


FIG. 2. DETAILS OF A SMALL AND A LARGE PIER

The concrete of each rib was poured in 20-ft. sections from each end alternately in order to avoid distortion, each rib being poured in one day's continuous pouring. The structural steel frame of the arch ribs supports the concrete until it becomes set, after which the steel acts as reinforcement. The behavior of this type of combined steel and concrete arch and the reason for its adoption are explained as follows by Prof. C. M. Spofford, of the firm of Fay, Spofford & Thorndike, who are designing and supervising engineers for the bridge.

Stresses in Steel Ribs.—The reinforcement of the arch ribs consists of riveted steel ribs with a limited amount of longitudinal rod reinforcement and with

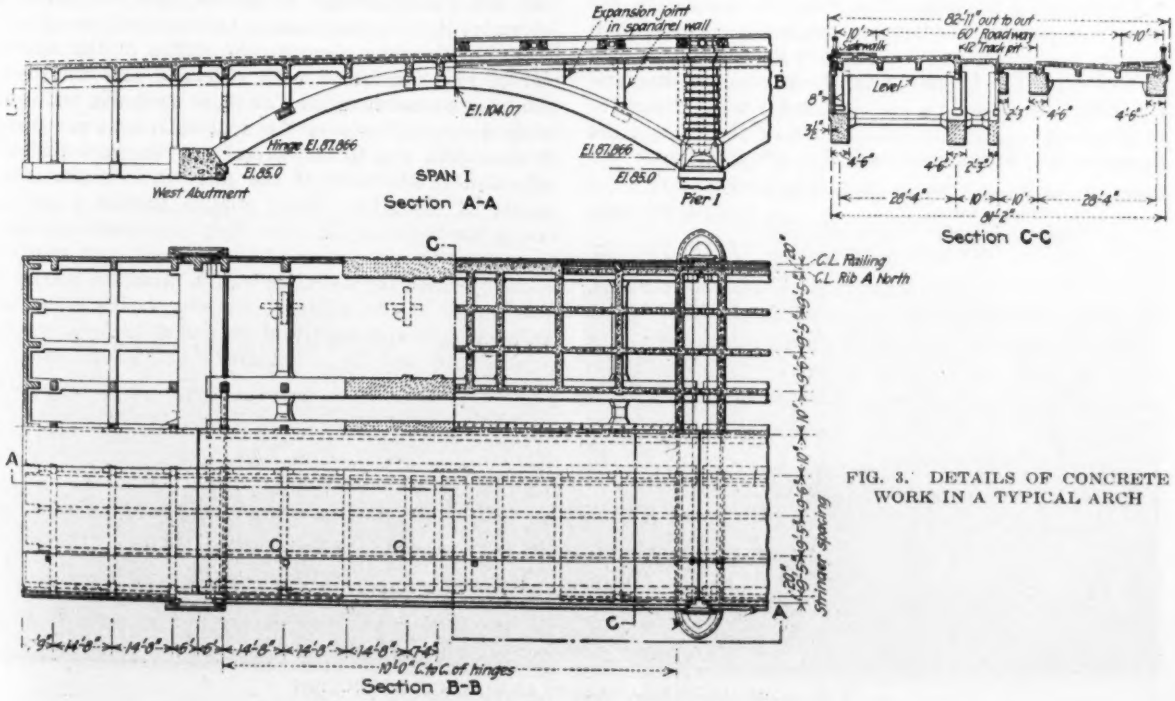


FIG. 3. DETAILS OF CONCRETE WORK IN A TYPICAL ARCH

hoops also formed of rods. The steel ribs were designed of sufficient strength to act as end-supported arches under not only their own weight, but also the weight of the rib concrete and the weight of the rib forms. These ribs were all erected as three-hinged arches, and were later spliced at the crown to act as two-hinged arches, the splice being made in the exterior ribs before the rib concrete was poured and in the interior ribs after the pouring of the floor. A limited amount of rib concrete at the crown in the interior ribs was temporarily omitted to permit the splicing of these ribs. This method of construction and erection obviates dead-load stresses due to rib shortening in the interior ribs which act as three-hinged arches under the dead-load; it also makes it possible to develop a considerable amount of initial stress in the steel in addition to its stress as reinforcement, a result which cannot be accomplished with rod reinforcement. In fact, the amount of initial stress per square inch thus obtained in the steel rib reinforcement is fully as great as the total stress per square inch which can be caused in rod reinforcement by the loading, and which cannot be greater than the unit stress in the concrete adjoining the rod multiplied by the ratio between the moduli of elasticity of the steel and of the concrete.

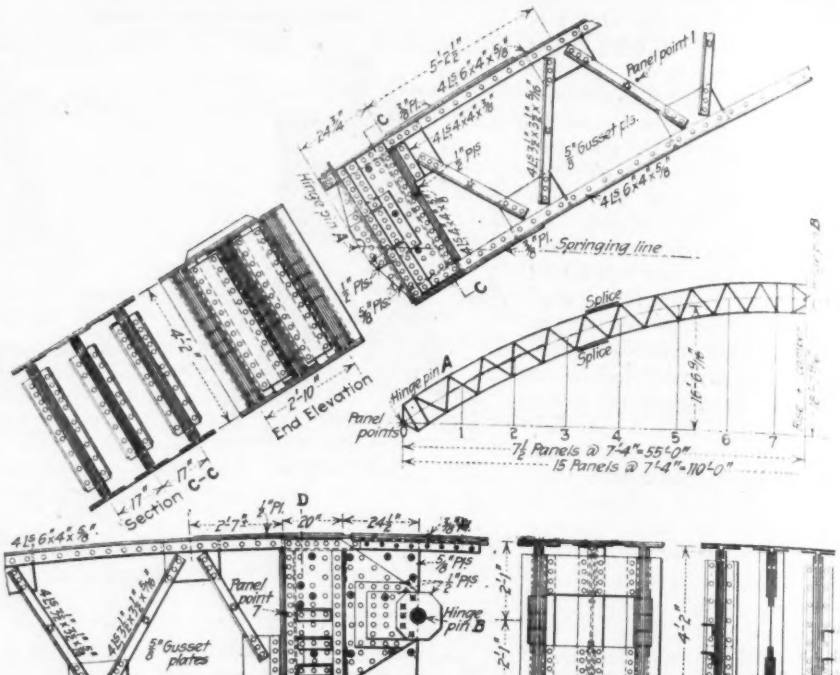


FIG. 4. DETAILS OF ARCH RIB REINFORCEMENT

The working stresses established for the design for live, dead, impact, and temperature stresses were 16,000 lb. per square inch in steel and 600 lb. per square inch in concrete. The actual maximum stresses in the various ribs were kept in close conformity with the above requirements. For example, in one of the ribs of the longest span the maximum stresses are as follows:

Steel.—Construction stresses due to weight of rib and forms	9,820 lb. per sq.in.
Stresses due to remaining dead load, live-loads and temperatures	7,570 lb. per sq.in.
Total maximum stress in steel	16,390 lb. per sq.in.
Concrete.—Maximum stress	593 lb. per sq.in.

The stress due to the loading in rod reinforcement at this particular section could not have exceeded 593 lb. multiplied by the ratio between the moduli of elasticity of steel and concrete, or say $12 \times 593 = 7{,}200$ lb. per sq.in. approximately. As a matter of fact, it would have been somewhat less than this owing to the reinforcement being located a short distance in from the extreme fiber. Hence the economy of material due to the use of the above type of structural steel rib is apparent.

Inasmuch as the steel ribs would cost more per pound than rod reinforcement, it was necessary in order to determine the relative economy of the two types of reinforcement to make comparative studies of the relative cost of ribs reinforced with rods and ribs reinforced with riveted members such as those used, due allowance being given not only to the additional cost per pound of steel ribs, but to the saving in falsework and the reduction in the cost of the piers due to the lesser weight of the ribs. These studies showed a marked saving for the steel rib type; they also showed it to be economical to make each rib in any one span constant in cross-section for its entire length, hence the maximum fiber stress at the different sections varies somewhat. An additional and important argument in favor of this type of ribs was the anticipated rapidity and easiness

FIG. 5. SPRINGFIELD BRIDGE DURING CONSTRUCTION

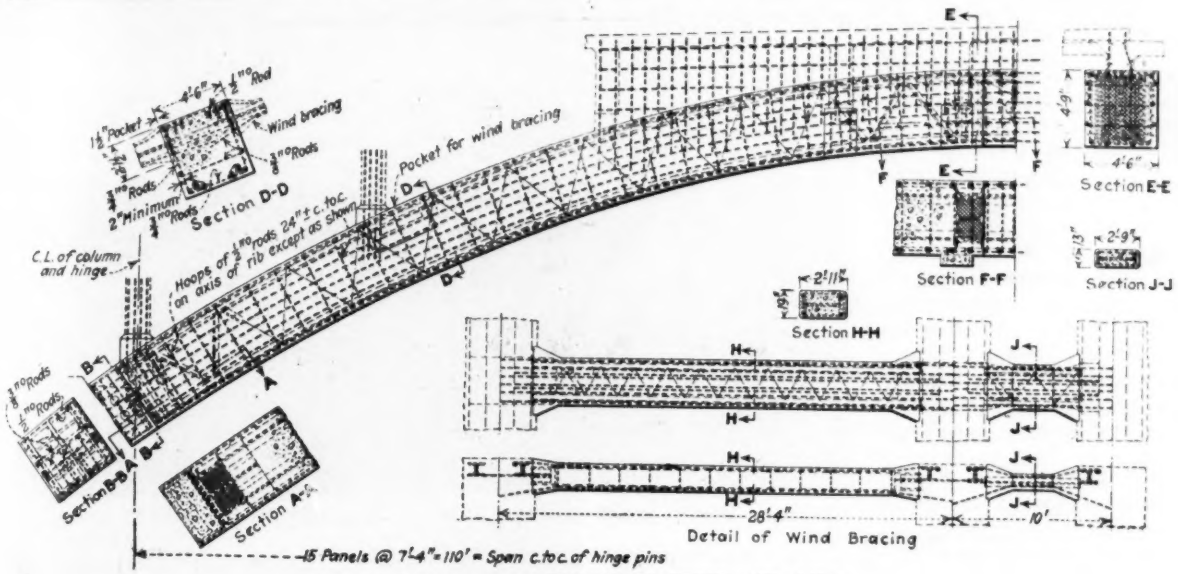


FIG. 6. CONCRETE COVERING TO STEEL AND RIBS

with which such ribs could be erected and the consequent lessening of danger to the permanent structure from floods and ice, an important factor in the Connecticut River. There was also the further advantage of simple connections to end hinges and of definite location of the reinforcement with respect to its position in the arch rib. These anticipations were fully realized during construction.

In determining upon the live-loads to be used in the design, the specifications of the Massachusetts Public Service Commission for bridges carrying electric railways were followed. The minimum requirements of the specifications provide a train of two 50-ton trolley cars coupled together, but they also provide that where steam road freight cars or express or other cars weighing more than 50 tons are to be operated, trains of two 75-ton cars shall be used in the design. In view of the permanent and substantial character of this bridge it was considered desirable to provide for the heavier cars, and these were used. Other provisions of the specification for live-load stipulate a uniform load of 100 lb. per square foot on roadway, or a 20-ton motor truck having 6 tons on one axle and 14 tons on the other axle; 100 lb. per square foot on sidewalks; and for the arch ribs 100 lb. per square foot for floor surface of spans 100 ft. or less and 80 lb. for spans of 200 ft. or over and proportionately for intermediate spans. Impact varying with the loaded lengths was also used. The temperature variation was assumed as plus or minus 40 deg. F.

Reinforced-concrete wind bracing was provided between the ribs in the form of horizontal struts but the wind stresses produced in the ribs were neglected in proportioning these members as these stresses were extremely small.

No direct allowance was made for stresses caused by shrinkage of the rib concrete during setting. Such shrinkage of the concrete would tend to bring it into tension and to cause some compression in the steel ribs, but this shrinkage would have no material effect upon the reactions since it would occur while the rib was acting as a three-hinged arch.

Since the rib axes are parabolas and the ribs are of constant cross-section, the rib stresses due to live- and dead-loads are practically constant throughout under full loading and while the maximum live stresses

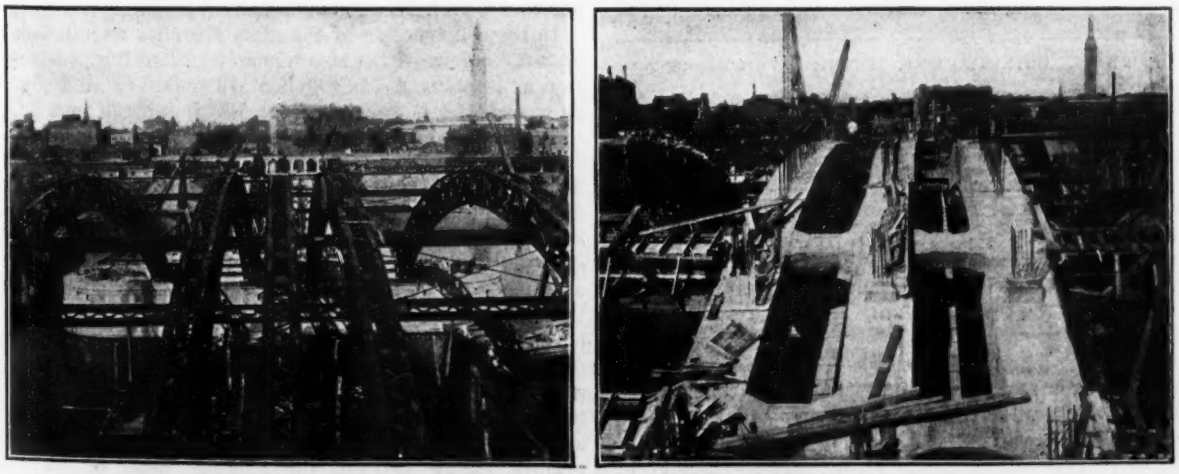


FIG. 7. ARCHES BEFORE AND AFTER CONCRETING

do not occur under full live-load, the difference between the maximum live stresses and the live stresses under full load was not found sufficient to warrant the additional cost in labor in making the ribs of variable cross-sections. The application of partial dead-load to the rib during construction caused stresses in the diagonals which disappeared when the arch rib was completely poured. Consequently, except for the condition existing during construction, the steel rib flanges act in the same manner as longitudinal reinforcing bars in the ordinary reinforced-concrete member, the diagonals serving as shear reinforcement. In order to reduce the construction cost, all ribs throughout the bridge were made of equal width, the ribs in the various spans varying in depth in proportion to the span length. The size, number and proper lateral spacing of the ribs to permit conformity with these conditions and at the same time to secure approximately equal strength were carefully investigated and the ribs spaced accordingly.

The roadway is to be paved with granite block. The bridge provides for a double-track street railway and

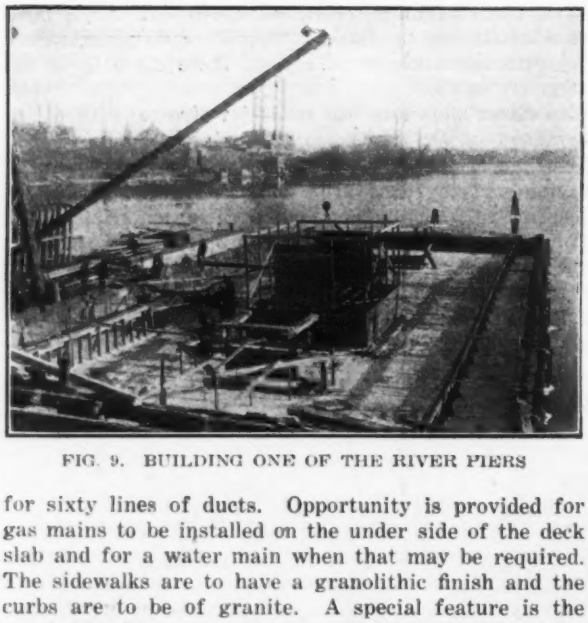


FIG. 9. BUILDING ONE OF THE RIVER PIERS

for sixty lines of ducts. Opportunity is provided for gas mains to be installed on the under side of the deck slab and for a water main when that may be required. The sidewalks are to have a granolithic finish and the curbs are to be of granite. A special feature is the provision of snow manholes near each end. These are in the roadway, easy of access for trucks, and are to be used in dumping snow taken from the city streets directly into the river beneath, thereby providing easy disposal.

Design of Viaduct Approach.—The viaduct over the railway yards at the east consists of nine spans 31 ft. long in the clear giving room for two tracks in each span. The piers in the bulk-freight portion of the yard are to be four-column bents permitting the passage of vehicles between the columns. Other piers are to be solid to a point above the tracks with small arches supporting the viaduct floor slabs.

FIG. 8. CONSTRUCTION TRESTLE AND CHUTING TOWER BARGE AT WORK

Construction Plant and Methods.—For construction, a temporary trestle was driven just upstream of the bridge connecting with the concrete plant on the west shore. At this plant crushed stone and sand are delivered by trolley from a trap rock quarry 11 miles away, and some sand is obtained by dredging from the river at the site, this latter sand being screened just outside the concrete mixer plant. Concrete is mixed in a ¾-yd. batch mixer and carried across the trestle in a train of two or three cars of 50 cu.ft. capacity, which are dumped into the receiving hopper of a chuting plant mounted on a lighter. This tower chuting plant moves up and down alongside the trestle and serves as a flexible link between the trestle and any place where concrete is to be poured.

Concrete of variable composition is being used, the requirements being varied from 1:1 with ¼-in. aggregate which is used as a dry mixture for the surface finish to a 1:12 with a ½-in. aggregate used for filling around the conduits. The major part of the work is 1:6 mix with a ¾-in. maximum aggregate for superstructure work and 1:7½ with a 2½-in. maximum for substructure and piers. Tests showing a compressive strength of concrete at 28 days averaged about 2,260 lb. per square inch for the superstructure.

In the construction of the piers the piles were driven on 2-ft. centers with a steam hammer to such a penetration as to carry a load of about 16 tons. In all 10,500 piles were used, varying from 700 in pier 1 to 2,263 in each of the channel piers. The length of piles varies from 20 to 40 ft. and they bring up on a solid stratum. The cofferdams as shown in some of the views, were of 6-in. grooved and splined sheetpiling driven around each pier after the bearing piles were driven. This sheetpiling was of Douglas fir from Washington and was about 36 ft. long. Concrete was placed on top of the piles through the water by means of bottom-dump buckets up to about 7 ft. below water, when a cofferdam bracing of heavy timber was placed. The water was then pumped out from inside the cofferdam, the top of the concrete placed under water cleaned off, a leveling course of concrete placed, and the laying of granite facing started, the average head of water against the cofferdam being about 10 ft.

An important feature of the project was the program of erection and of concreting of the arch spans, which was incorporated in the specifications and rigidly adhered to during construction. This program was worked out with great care to prevent, during construction, the occurrence of unbalanced thrusts on the piers in excess of those contemplated in their design.

The bridge is being built by Hampden County, under the direction of the County Commissioners. The designing and supervising engineers are Fay, Spofford & Thorndike, of Boston, with George L. Mirick, construction engineer, and C. A. Farwell, as resident engineer, Haven & Hoyt of Boston, have served as advisory architects. The contract is held by H. P. Converse & Co. of Boston, with G. A. Follett as superintendent. The steelwork of the arch ribs was fabricated and erected by McClintic-Marshall Co., of Pittsburgh.

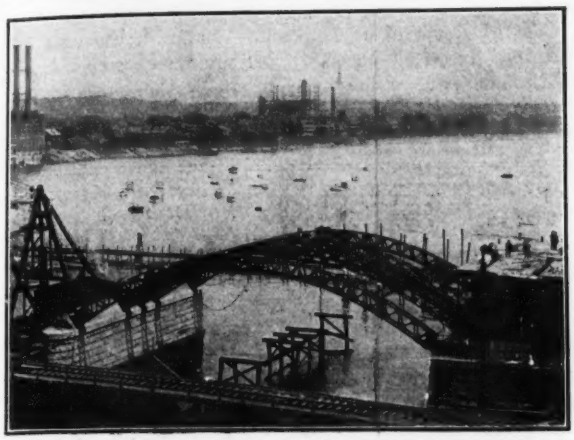


FIG. 10. STEEL RIBS IN PLACE ON ONE ARCH

Wheel Hoists at English Engine Terminals

Hoists and drop-tables of types unusual in this country for the removal of wheels and axles from locomotives under repair are described in a recent number of the *Railway Gazette*, London, by W. Land, district locomotive superintendent of the Midland Ry. The hoists or sheer legs are three- or four-leg triangular steel towers spanning a track in the yard or engine-house and having a heavy tackle suspended from the apex. The hoist is operated either by hand or power. With the locomotive blocked in position, one end is raised until the frame pedestals are at sufficient height to enable the desired axle and pair of wheels to be run out. This method would not be applicable to very large or heavy engines. The other method consists in the use of a drop pit with platform elevator, the platform normally forming a part of the repair track and being suspended at the corners by cables from a rectangular frame or tower which is high enough for engines to pass through it. The engine is placed on the track with the wheels to be removed standing on the elevator. When the pedestal connections are removed, the elevator is lowered, carrying the wheels with it. Two horizontally sliding platforms are then run out from the sides of the pit, so that the engine can be removed, either on its own wheels or on shop trucks. When these platforms have been returned to their recesses, the elevator brings up the wheels, which are then rolled along the track to the machine shop.

How Grit Chambers Work at the Worcester Sewage Plant

By Ray S. Lamphear
Supervising Chemist, Sewage-Works, Worcester, Mass.

THE function of grit chambers at sewage-works is generally well known but data concerning their operation are meager. The grit chambers at Worcester consist of two units, each rectangular in section, 40 ft. long, 10 ft. wide, and 9 ft. deep to the normal water line. The pit section is 6 ft. deep and the normal flow channel 3 ft. deep, while the dividing wall is 10 ft. high, or 1 ft. above normal water level. The inlet and outlet channels are 3.5 ft. wide and 4.4 ft. deep; the gates are of approximately the same width and height, and are lifted by hand by using a lever in connection with a gear and rack at the center of each gate. A gravel drain, about 8 in. deep, was provided in the bottom of each pit to carry the water to an outlet gate, but proved impracticable in use so that dewatering of the deposit has been done by digging sump-holes in the deposit at the ends of the pits and using diaphragm pumps.

At the time of the construction of the chambers, in 1904, the outfall sewer was 42 in. in diameter; in 1915, the present 72-in. sewer was placed in operation without alteration of the chambers. Large storm flows result in an approximate water depth of 12 ft. in the chambers, the dividing wall and the gates being submerged.

Velocity of Flow. — The velocity of flow of sewage through the grit chambers should be about 1 ft. per second and slightly less when storm flows occur. A theoretical velocity of 1 ft. per second is attained when the rate of flow is 1,000,000 gal. per hour but the entrance velocity and the pit section tend to change this figure and observations indicate that the actual average velocity is greater than 1 ft. per second at this rate of flow, especially in the inlet half of the chamber.

Operation.—One chamber is generally used and the second placed in operation as the increasing rate of flow, due to storm water, approaches 1,000,000 gal. per hour, and both are continued in use until the flow decreases to nearly normal.

Operation as concerns period of service between cleanings has been influenced by two factors: Cleaning by hand labor and by the use of an auto-crane, generally used on sewer construction and moved to the chambers for the purpose of cleaning both chambers on successive days. In the first instance, the chamber must be entirely filled with grit material and in the second, while such condition is of advantage, it is not an absolute necessity.

Experience has shown that grit chambers should always be cleaned after sewage has been passed through them for some hours and not after the chamber has been cut out for some time. In the latter case, soft deposit, with rare exceptions, is found on top of the grit and interferes with dewatering and removal of the deposit.

Deposition of Material.—Deposition of some organic matter is bound to occur during the early morning hours and on Sundays, when the sewage flow is small. As grit accumulates, much of the softer material is displaced and, when the chambers are to be cleaned by hand labor, operation must be continued until practically all of the soft deposit is forced out by the

heavier material. Frequent measurements of the depth of deposit indicate the character of the deposit and the gradual accumulation of heavy deposit from the inlet to the outlet end of the chambers. The entire length of the chamber is used even though the entrance velocity is great, but on account of sudden changes of velocity there are so-called pockets in the deposit close to both gates.

Quantity of Deposit. — Previous to the use of the larger outfall sewer, the average quantity of deposit removed per million gallons of sewage passing was about 2.4 to 2.7 cu.ft. Since 1915, the average quantity of deposit has varied from 1.4 to 2.2 cubic feet per million gallons of sewage. The decrease is explained by the increased proportion of storm flow, carrying no grit, which now comes to the plant and formerly was discharged at an overflow located at the entrance to the smaller outfall sewer. A by-pass to the river is used when the rate of flow exceeds 54 m.g.d., and while some grit does not enter the chambers, all first flushes of storm-water flow pass through the chambers. The rate of accumulation of deposit necessarily varies with the number and character of the storms and the season of the year. During the spring of the present year, the deposit accumulated at a minimum rate of 1.5 cu.ft. per million gallons and during the past two months [written Nov. 16], it accumulated at a rate of 4 cu.ft. per million gallons of sewage.

Character of Deposit. — The proportion of mineral matter in the deposit is usually about 75 per cent; of volatile matter, 25 per cent. As dewatered for hand labor cleaning, the moisture content is about 35 per cent. The nitrogen content is usually about 0.5 per cent. Generally, a considerable quantity of rags, tin cans, balls and small metal pieces of various character are found. Purses containing money and a perfectly good Waterman Ideal fountain pen have been found, while rings have never been noticed although frequently being reported as lost.

Grit May Be Used for Dikes or Roads

When the chamber has been allowed to become entirely filled, the material is suitable for dikes or roads but its odor is somewhat offensive and prevents its general use for road purposes close to dwellings.

Method of Cleaning Chambers: As stated above, two methods have been used for removal of grit. Removal of approximately 90 cu.yd. of deposit, or the contents of one chamber as measured in place, by passing to two stagings, then to the ground, a distance of 16.5 ft., and then into carts, requires a gang of 10 men, including the one at the dump. A haul of about 900 ft. requires the use of two double carts. Considerable difficulty has been experienced with labor, especially during 1918 and 1919, on account of the heat and odor.

With the exception of one cleaning of each chamber, an auto-crane, having a ¾-cu.yd. clam-shell bucket, has been used for removal of the deposit since October, 1919. The labor, other than the two men with the machine, is reduced to four men. Three teams are used and the time required for cleaning one chamber is reduced from about 14 or 15 hours to 6 or 7 hours. This method is quicker and cheaper and indicates what permanent mechanical equipment would accomplish. The machine is not especially fitted to the present lay-out and shrubbery interferes with its proper location.

The objection to special mechanical equipment for cleaning grit chambers is the investment required for an installation which would be used comparatively little. The interest on the investment and the depreciation of value of the equipment tend to make the cost of cleaning fully as much as by hand labor. Where grit accumulation is rapid, and frequent cleaning is required, mechanical equipment would result in a decreased cost of cleaning grit chambers as compared with shoveling by hand.

Cost of Removal of Deposit. — In 1914, the cost of cleaning, based on 90 cu.yd. per chamber, varied from 45 to 55c. per cubic yard; in 1919, the same figure varied from $1.15 to $1.30. Later in the year, the chambers were cleaned with the auto-crane for approximately 60c. per cubic yard, including the charge of $1 per hour for the machine without operator and fireman.

COST PER CUBIC YARD OF CLEANING GRIT CHAMBERS AT WORCESTER SEWAGE-WORKS, 1920-1921.

Date	Dec. 4-6	Jan. 31-Feb. 1	Apr. 27	May 14	July 21-22
Getting chambers ready	$0.07	$0.23	$0.26	$0.28	$0.05
Labor	.27	.20	1.23	1.15	26
Teams	.28	.35	.46	.50	33
Auto-crane and 2 men	.19	.23	.....	.....	22
Total	$0.80	$1.00	$1.95	$1.93	$0.86

The cost of cleaning may be divided into three or four parts, and those of the present fiscal year are given in the accompanying table on a cubic yard basis.

The cost of dewatering the grit deposit shows considerable variation, due principally to the available labor and time which can be given to it. In April and May, the chambers were cleaned without the auto-crane and the expenditure shown was none too great. The charge of 23c. in January as compared with 7 and 5c. in December and July is explained by the reason that the chambers were cleaned when not entirely filled with grit deposit. This was done to facilitate moving the auto-crane to the chambers during favorable traveling conditions. This charge accounts for the increased cost of cleaning as compared with the other two machine cleanings.

The data indicate the considerable reduction of cost of cleaning of grit chambers that can be effected with mechanical equipment. Provision of proper draining facilities, such as protected gates in the side walls, equipment especially suited for the work and a short haul to a point of disposal, would result in a further reduction in the cost of cleaning. It is known that the time consumed in cleaning a chamber with the auto-crane is excessive for it has been impossible to have carts always waiting to be filled. The cost per cubic yard of cleaning the chambers with proper facilities should be reduced fully 50 per cent.

A Large Rotary Sewage Sprinkler

An electric motor-driven rotary sewage sprinkler covering a bed of 200 ft. in diameter at Chichester, England, has been replaced with an automatic rotary distributor which covers 180 ft. of the diameter of the bed. The original sprinkler, according to a statement attributed to F. J. Lobley, city surveyor of Chichester, by London *Municipal Engineering*, was "not satisfactory and was worn out." The new distributor was installed by the Ames Crosta Sanitary Engineering Co. of Nottingham, England.

Notes on Canal Projects in Southwestern Germany

Status of Rhine-Danube Section of Baltic to Black Sea Route—Hydro-Electric Projects Linked with Canalization

By Karl Haller
Doctor of Engineering, Langenau in Wurttemberg, Germany

FOR SCORES OF years, there have been persistent endeavors in Southwestern Germany to effect a water connection between the Rhine and the Danube. At present, it is expected to achieve this purpose in a double manner. As the map in Fig. 1 shows, this can be partly done by the canalization of the Main between Frankfort and Werenfeld and also between Schweinfurt and Bamberg by the so-called Bavarian Line, and in the south, it can be done partly by the canalization of the Neckar through Baden and Wurttemberg.

This map shows that for large-vessel traffic along the Neckar Line, the original bed of the river may be used from Mannheim as far as Plochingen. From Plochingen to Ulm and from Ulm to Regensburg and Friedrichshafen, special canals have to be built to handle ships of 1,200 tons.

For the economic life of Baden and Wurttemberg, the Neckar-Danube Canal project is of the greatest importance as these two sections of southwestern Germany have no sources of supply of coal of their own. It is particularly because of the lack of coal in this section of the country that the utilization of the Neckar and the Danube for purposes of power generation forms the main purpose of consideration in connection with all these projects. The conditions for hydraulic power generation are here very favorable. According to the report made by Dr. Eng. Boehmler of the Gruen and Bilfinger Co., on the section of the Danube River between Ulm and Kehlheim, 800,000,000 kw.-hours can

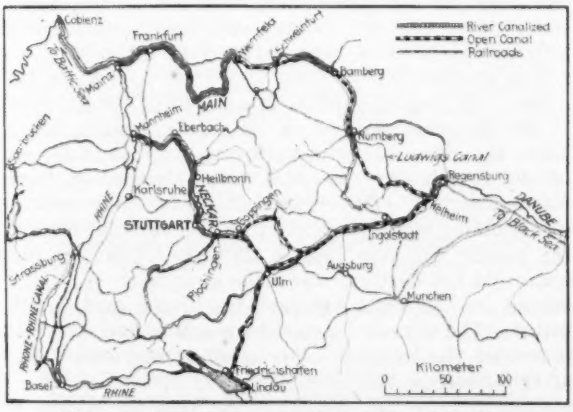


FIG. 1. PROPOSED CANALIZATION PROJECTS

be developed. Equally favorable are the conditions on the Rhine-Neckar Canal route between Mannheim and Ulm. The Rhine at Mannheim is 90 m. and the Danube at Ulm, 464 m. above sea level. The mean flow in the Neckar between Mannheim and Plochingen at average water level is 58 cu.m. per second with a fall of 157 m. from one end to the other of that stretch of the river. If this fall be utilized fuller one may expect a development of 70,000 hp.

In designing the power-generating stations, the prevailing rule in Germany, which is to concentrate large heads of water at a few points rather than to utilize numerous small water falls, has been made use of.

An increase in the utilization of water power far above the usual amounts can be achieved by the following measures: (1) By making the head of water fall in each stage as high as possible. (2) By decreasing the head losses in the weir canals wherever these have to be put in. (3) By designing the power plants to handle larger amounts of water, even when these are available only for periods of 100 to 120 days during the year. (4) By inter-connecting the power plants. (5) By the installation of so-called "day reserve basins."

Arranging the water falls in high stages is desirable also from the shipping point of view as this makes for longer trips and fewer sluices as well as smaller losses of water and time at the locks. In order to reduce to the minimum the head losses in weir canals, an effort is made to make the canal walls smooth, and wherever possible, to cover them with concrete.

When large supplies of energy are concentrated in the hands of a single enterprise, considerable advantage is derived from the fact that the various power requirements by different consumers can be appropriately and

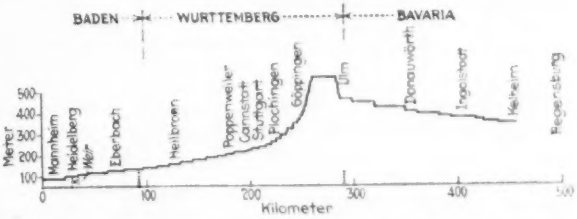


FIG. 2. CANAL PROFILE—MANNHEIM TO REGENSBURG

economically regulated from the point of view of time and volume of demand and also that the stand-by steam plants may be handled in the shape of a few big units.

In order to utilize fully the available water supply for purposes of power generation, it is desirable that as a rule the excessive night flow be utilized. The water that would otherwise run away at night is to be collected into a day reserve basin and be used as an additional supply to the general river flow during the day. Tests with such day reserve basins carried out at the Poppenweiller power plant near Stuttgart have shown entirely satisfactory results.

Fig. 2 shows the longitudinal profile of the Rhine-Neckar-Danube canal which brings out the very steep rise over the Swabian Alps, where it is intended to construct a canal 23 km. long, while another solution proposes the piercing of the Massive of the Alps by a ship tunnel 24.5 km. long. In order to overcome the head in the locks, which may be as high as 30 m., special "dividing sluices" have been provided. This type of sluice is not only easily adaptable to all kinds of terrain but can be applied to very bad underground conditions. The reduction of machine parts with this type of construction is of such material advantage that the new type becomes preferable to the old established chamber lock.

As regards the cost of construction of the Rhine-Neckar-Danube canal, it has been estimated at 2,000,000,000 marks for the stretch as far as Plochingen. It is a question yet whether the necessary means for building this canal may be secured owing to general economic conditions. So far, only 50,000,000 marks have been provided for its construction so that the first work, which will be undertaken this spring will be

in Wurttemberg where the construction of the power plant Horkhein at Heilbronn will be begun.

In view of the fact that the construction of the Neckar-Danube canal is of vital importance for the future development of the economic life of southwestern Germany it would appear that foreign capital would find in this enterprise a safe investment opportunity.

Main Project.—As the writer was in charge of construction of one of the sections of the Main canalization, something might be said here as to the execution of this engineering undertaking, carried out during the World War.

The damming works executed consist of a ship sluice to handle vessels up to 1,200 tons, a roller weir, a power plant and a raft chute 300 meters long and 12 meters wide. The latter was considered necessary because of the large amount of Bavarian timber rafted towards the Rhine. Besides the raft chute there are in the weir plant two more side openings each 30.61 m. wide and the ship passage, 40 m. wide. The left shore raft chute is closed by means of a rotary weir. Iron roller weirs have been adopted for the other weir locks.

The hydro-electric power plant, which contains four vertical Francis turbines, is set parallel to the river flow, to economize shore location. Each of these four turbines delivers 590 hp. at 30 r.p.m. with a head of 1.80 m. and a flow of 30 cu.m. per second.

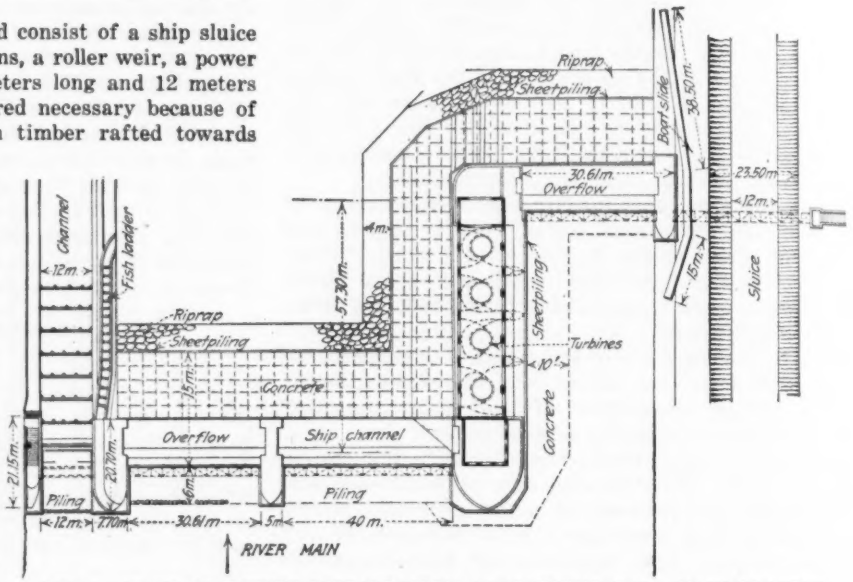


FIG. 3. PLAN OF ENTIRE INSTALLATION AT MAINKUR DAM—MAIN PROJECT

The sluice on the right-hand shore has a width at the bottom of 12 m. and is of the tug type. Into the sluice dam has also been built a "boat slide," through which the small boats are passed. Their construction is simple, being essentiaaly the placement of two oak beams held by bolts into a concrete foundation 50 cm. thick. As the end surface of the boat is kept smooth by the action of the water, the boat on the "boat slide" can be easily carried over by manual labor.

Both slopes of the dam are paved. The sluice walls are lined with smoothly worked stone squares and the sluice bottom is paved to the length of the lock heads. In order to provide for a certain amount of buoyancy there were used at the upper lock separate concrete prisms built in place. The individual prisms are held together by means of small iron plates that move vertically in slots, permitting a vertical freedom of motion to the concrete bodies themselves.

A plan of the entire installation of the works at Mainkur is given in Fig. 3. Both the forward walls (6 m. wide) ahead of the dam rollers, and the storm walls (15 m. wide) back of them, as well as all the single piles, etc., are all built between sheetpiling.

The proportions of the concrete were for the foundations of the turbine columns: 1 part cement, ½ part trass, 4 parts sand, 8 parts gravel; for reinforced concrete 1 part cement, 2.5 parts sand, 5 parts gravel; for packing, 1 part cement, 3 parts sand; for front and storm walls at the weir, 1 part cement, ½ part trass, 5 parts sand, 9 parts gravel; for all the other structures 1 part cement, ½ part trass, 4 parts sand and 8 to 10 parts gravel. All concrete was machine mixed and tamped with compressed air ramming machines. The paved bays of the front and storm walls were put up 3 x 3 m. wide; at the edges, strips of asphaltic roofing paper were set into the expansion joints. On the concrete foundations (50 cm. thick) of these weir walls was set a sandstone paving, 35 cm. thick, with here and there courses of headers. The paving was placed with a 1:4 cement-mortar mixture set into fresh concrete. The raft chute on the left shore had both the slopes and the bottom protected by paving, 35 cm. thick set on a 1:4 cement-mortar mix over a ballasting 25 cm. thick, in addition to which on the bottom, 12 m. wide, there were set, 5 m. apart, heavy wooden sills, attached by bolts to piles driven into the soil.

The construction was not free from unpleasant surprises. In December, 1916, as a result of sudden thaws in the Bavarian forests in the upper reaches of the river, the river rose with such rapidity that at the end of the fourth day the sheet piling located upstream was submerged. The water continued to rise until the pile planking with which the trenches were cut off from the stream was also broken through. What the high water did not destroy, was made away with by the following ice floe which enlarged the breach made by the water. The wooden framework inside of the steel piles prevented the complete destruction of the work. Only after numerous difficulties had been overcome, and six months of time lost, did it become possible to close up the trench, and start work anew. Though much of the work was done during the war, the power plants were not put into operation until 1921. The sluices have been in operation since 1917.

Health Investigations in French Cities

Under a recent order to the French Minister of Health sanitary assemblies of towns and communes in which the 1920 general death rate was in excess of 17.2 per 1,000 are required to make investigations designed to show the reasons for the excessive death rate and to report what steps have been taken for its reduction.

How Practising Engineers May Sell Their Services

Methods of Securing Clientele and Increasing Business Discussed in Two Papers (Abstracted Below) at the Conference of Practising Engineers, Held in Chicago Feb. 22, under the Auspices of the American Association of Engineers

Reaching the Prospective Client

By Paul E. Green
Consulting Engineer, Chicago

MOST of a practising engineer's success is due to his ability to sell his services. Quite frequently the men who decide to enter private practice have no experience in selling their services and have inadequate capital. It is my opinion that a two-man engineering firm needs a cash capital of not less than $15,000 to handle $25,000 to $30,000 of professional work per year.

Sources through which professional work may be secured may be classified as follows: (1) Other engineers; (2) municipal, state, county and other political subdivisions; (3) private corporations; (4) individuals. From other engineers work is secured because of a good reputation with them. This is a most satisfactory way in which to receive work. It comes only from extensive acquaintance secured by joining technical societies and taking active part in them, by contibuting articles to the technical press on the specialities with which the engineer is best acquainted, and by personal acquaintance socially or through common employment.

Municipalities, which are probably the most prolific source of work, are approached in various ways. Even in the large city the city engineer often has little to say as to the selection of a consulting engineer, who may be employed by a council committee or a lay commission. Frequently this work is secured by direct solicitation.

Direct Solicitation Necessary—Even a prominent engineer often is unknown to the public. In spite of the fact that he has been active in a technical society, has contributed to the technical press and is well known to the men of his profession, it is necessary in two cases out of three for the firm and individual to solicit directly, even in large cities. Certainly it is true with the smaller municipalities. Circular letters and similar advertising appeals are sent out by the thousands by various engineers. Every mayor and city clerk receives dozens of them each year. The percentage of replies is small. We have found that circular letters sent out in lots of 2,000 and 3,000 brought less than 0.5 per cent of replies. When accompanied by self-addressed envelopes and in normal times, the replies were about 10 per cent, of which 90 per cent stated that there was nothing doing. However, some direct results are obtainable and it is an important method of securing advance tips on work.

Clipping bureaus, advance reports and similar methods of getting information as to prospective work, we have found, do not pay for their cost, since the items were too late for the engineer. Articles contributed to the technical press form one of the most valuable means of reaching the prospective client, both city officials and employing concerns.

Work for private corporations is a highly desirable field and often requires solicitation, though not to the same extent or of the same character as is required with municipalities. Once secured as a client, the corporation seldom looks elsewhere. It is, however, more difficult to get advance information from private corporations and much of the work is given out as the result of acquaintanceship and technical reputation. Private individuals from time to time have considerable work, but not much of this can be secured by solicitation. It comes largely because of acquaintanceship and a considerable amount of this work is secured through the friendship of the higher class of contracting supply men.

No tip should be ignored. Nine out of ten are worthless but the tenth may be very much worth while. A source of work which is quite valuable as the age of a firm grows is from previous employees. If they have departed in good feeling and have a respect for the firm they are a valuable source of information. This illustrates the fact that a successful organization is successful partly because it treats its employees in the highest and best manner.

One of the most important points in selling engineering services is the character of the work performed. At least 50 per cent of the firm's clients will have additional work to do after a season or two. In the municipal field this does not mean that the old firm will always be re-engaged but if your work is well and conscientiously done, when the time comes around for additional work you will get it often without competition. If friendly relations are maintained with municipal officials they frequently will tell of other work. Various state departments from time to time have employment for the consulting engineer in water supply, highway and paving work, sewage disposal, drainage and hydraulic developments. They also, because of their activities, recommend considerable work of this kind to other political sub-divisions of the state. By keeping in touch with these departments a line is frequently had on prospective work.

One difficulty which the engineer in private practice meets is the general confusion in the public mind as to what "engineer" means. Very frequently the layman considers that an engineer is a builder or contractor. The same confusion does not exist with the word "architect." It would seem as if a campaign to educate the public along this line would tend largely to increase the field for the practising engineer.

Personal Contact—No campaign for professional work will be of any great benefit if it is not followed up by close personal contact. Very little work which is not the result of recommendation by another engineer or another client can be secured purely through correspondence. I lay this down as a fundamental principle based on the result of years of experience. From time to time there enters the unexpected employer, such as the attorney who wishes expert services for court work, the promoter who wishes to develop some idea along engineering lines or the club member who is confronted by a problem. Most of these come wthout solicitation and as a result of personal contact which had nothing to do with engineering. Work from such sources increases as years go on and much of it comes from a genial interest in the other man's affairs.

A final source of employment, not unimportant, is that which may be developed through political activity in its better sense. Other professional men have done much of this, with an increase in prestige. It would be well for engineers to take an active personal interest in politics, as members of party organizations.

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Advertising for the Practising Engineer

By Morris W. Lee
Vice-President, Frank D. Chase, Inc., Chicago

IN THE first place, what is advertising? Where does personal solicitation leave off and advertising begin? How can the practising engineer get business unless he goes after it in some way? Then what does he do to get business? He starts in by telling his friends and acquaintances that he has an office, is qualified to do certain work and would like some work to do. If he has a little nerve he takes a card or small space in an engineering paper. Advertising

in its best sense is disseminating by the printed word information about an article or service which is calculated to affect favorably the sale of that article or service. It is a tool, and its effectiveness depends upon the way it is used.

Should the practising engineer advertise; and if not, why not? Outworn codes of ethics, timidity, custom and the popular opinion gradually formed from these, seem to have set a limit to those who may advertise. But it is a wholly artificial limit. In discussions with engineers regarding advertising I have found no logical objection to it. Some of them say that strictly professional advertising becomes self-praise if carried beyond a simple statement of the service offered for performance. Some engineers say they prefer to let their works speak for them, but the same engineers countenance and even promote the publication of articles descriptive of their works, in order that they may be more widely known. Then why the great distinction between the text pages and the advertising pages of a publication? Doubtless it is because the text pages are supposed to be what others say of one, and the advertising pages what one says of himself.

The best test of whether advertising is ethical is the test of its truthfulness. If it states the truth, there is no justifiable objection to it. Only the statement of untruth is to be condemned, and this will fail of its own weakness in due course without other condemnation. It would seem logical therefore to agree that there is no sound reason from an ethical, moral or business standpoint why the engineer should not advertise.

Does Advertising Pay?—The proposition then narrows down to will it pay? That is a far more difficult question to answer. For many engineers it doubtless would not pay. For some who exercised the necessary skill, care and perseverance, it unquestionably would pay well. Some engineers can afford to continue in business until they can build up a reputation by word of mouth. But is it the best plan? Advertising is not merely buying space and filling it with type matter or sending out circular matter. It requires judgment, and there are far less specific data upon which to form that judgment than exist in engineering practice. First there is judgment required as to the proper monthly or yearly appropriations. Then the local, national or trade mediums to be employed; the method of approach, the selection of the ideas best calculated to produce the desired end, the choice of advertising agency, the style and wording of copy and use of illustrations.

In his advertising the engineer should start with a publication which he believes will reach most effectively his particular clientele. Let him use that publication intensively. For example, a paper mill engineer should start out in a publication reaching paper mill owners. The foundry engineer and the designer of textile plants should use appropriate mediums. The temptations will be great to spread out with small cards or small spaces in a large list of papers or directories, but this temptation should be resisted.

There is a great deal of direct-mail advertising being done nowadays, and much of it is productive. But this method of advertising has increased greatly in volume, so that to be effective it must be high class in character and distributed with discretion. This is only another illustration of the judgment required in advertising. Of course this judgment is developed, as in other fields, by the practical use of advertising and the observation of results secured.

Follow up Inquiries—So let the practising engineer or firm of engineers start out on a moderate scale. Let them state clearly the work they are prepared to do and why they are qualified to do it. Let them show specific examples of work well done and favorable comment on their accomplishments. If they place these announcements in reputable papers circulating among buyers of such engineering services as they supply they will get inquiries. Then let them go out on those inquiries and work like beavers to sell their services.

Popular opinion or custom seems at present to set curious limits as to who may or may not properly advertise; but as this becomes less arbitrary there will be more opportunity for the practising engineer to advertise himself. There is also a reticence among engineers about putting themselves forward and making their achievements known. Consequently the public at large talks loosely about "great engineering feats" as if they were merely manifestations destined to appear in the natural order of things and not the result of conscientious and often self-sacrificing application by many engineers to problems affecting the community or the race. Effective advertising by straight-thinking engineers would do much to remedy this and bring about a due recognition of engineering ability and value. It would thus be of substantial service to the individual engineer as well as to the profession.

Steel Rails Embrittled by Welding Bonds

DECIDED weakening of steel T-rails by attaching electric rail bonds by welding has been found, through tests carried out in connection with the development of a theft-proof rail bond for the Mexico City street-railway system. The tests were made by the Pittsburgh Testing Laboratory for the Canadian Engineering Agency, Inc., of New York, and indicate that drop-test results on rails with welded-on bonds are less than one-half as good as the results obtained with corresponding pieces of rail having no bonds attached.

Loss of exposed copper bonds by theft became serious enough on some lines of the Mexico system to make a concealed bond desirable. C. E. Winblad, of the

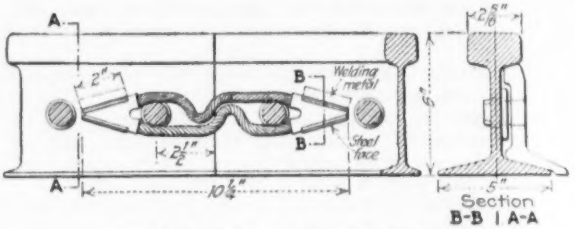


FIG. 1. STEEL-FACED RAIL BOND

Canadian Engineering Agency, engineer for the system, devised a bond of the form sketched in Fig. 1 herewith, comprising two strands of No. 0 copper cable connected at the ends by spear-shaped cast copper terminals faced along the outer edge with ⅛ in. of steel. The bond was designed to fit under the standard splice bar, passing around the bolts, and was to be attached to the rail web by means of electric arc welding of the steel facing to the rail metal. To determine whether this method of attaching a bond affected the strength of the rail, comparative drop tests were made on 4½-ft. lengths of the rail (70-lb. T-rail, 6 in. deep), under the standard drop-test machine of the American Railway Engineering Association specification (2,000-lb. ram with 15-ft. drop). Bonds were attached to about half the number of test-pieces, in some cases with one of the terminals at mid-length of the specimen, in other cases with the two terminals symmetrically placed with respect to the mid-length of the rail. No more welding material was used than would be considered good practice, the test report states, and the welding process did not heat the rail to a noticeable degree.

In the tests, the unbonded rail specimens broke on the third to fifth blow, while the bonded specimens broke on the first blow. In a second series of tests the height of drop was reduced to 10 ft.; the unbonded specimens broke on the fourth to fifth blow, while the bonded rails broke on the first or second blow.

Quite abnormal shapes of fracture resulted in the case of the bonded specimens, moreover. Fig. 2 here-

with, showing two unbonded and four bonded specimens, illustrates this point.

It was concluded from these tests that "serious injury is done to a rail by the welding process applied to its web," and the welded bonds therefore were not adopted

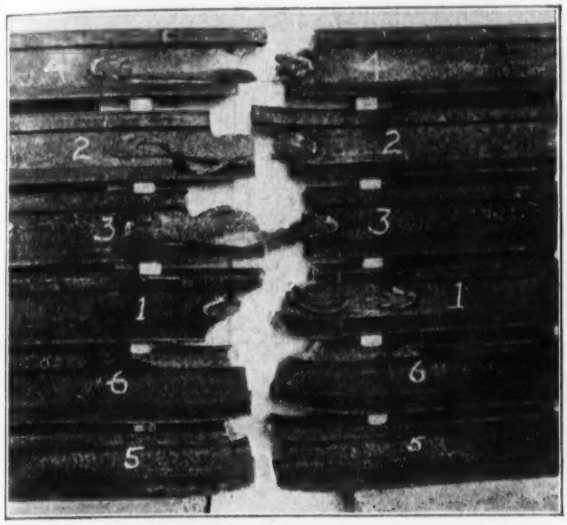


FIG. 2. DROP-TEST FRACTURES OF BONDED AND UNBONDED RAIL

for use. A form of bond passing under the splice and attached to head or base of the rail by welding may be adopted, however, as welding to the more massive parts of the section is not believed to injure the rail.

Rights of Trucks To Main Streets Upheld

An opinion was recently submitted by the Town Counsel of Milton, Mass., suburban to Boston on the direct line between that city and points north, and Brockton, New Bedford, Providence to the south. Certain citizens of Milton were much disturbed by the noise of big trucks which ran almost continuously through the night, using the streets of Milton simply as a thoroughfare. The selectmen of the town received a petition in which these citizens asked that the trucks be declared a nuisance and that the streets be closed to them, at least during the night hours. The jar and the noise were said to be so unpleasant as to interfere seriously with the rest of those who lived on these main highways.

The selectmen referred the matter to their counsel. He quoted a section of the general laws in which the selectmen of the town are given power "to make specific regulations as to the speed of motor vehicles and as to the use of such vehicles on particular ways, and may prohibit the use of such vehicles altogether on certain ways . . . provided . . . no regulation shall be valid which excludes motor vehicles from any state highway or from any main highway leading from any town to another."

The opinion went on to state that the clause last quoted would prevent the exclusion of motor trucks from this particular highway, since it was a main highway leading from one town to another. He stated also that although the statute is not express in the matter, an exclusion for a part of the day would be held to be prohibited by this clause.

Fast Loading of Motor Trucks Speeds Road Work

Moving Trucks Trip Measuring Box Gates Sand Washer Pump Operated by Fordson Tractor—Truck Turntables Used

AUTOMATIC charging of motor trucks while in motion cut down the hauling time on concrete road construction last season in Susquehanna County, Pennsylvania. One-batch trucks, serving a 21-cu.ft. mixer, were charged with sand and stone invariably in 10 to 12 seconds and on occasions were charged in 6 seconds. The average loading time was 8 seconds. With this quick loading outfit and a well organized gang at the mixer, over 500 ft. of road per working day was built.

Six miles of 18 ft. reinforced concrete pavement from New Medford to Hallstead were being constructed, according to the standards of the Pennsylvania highway department. Stone had to come in by railway but a pit about ½ mile from the New Medford end was developed for the sand. With a sand washer at the pit and the unloading plant and switch about a mile further

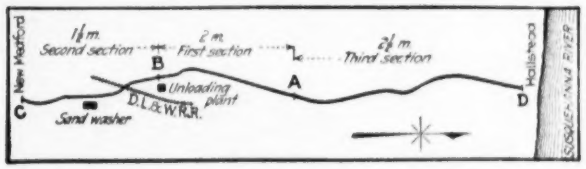


FIG. 1. PLANT LAYOUT AND PAVING SEQUENCE

on, as indicated by Fig. 1, the maximum haul was 4½ miles. With dry batch haulage by Ford trucks planned, it was decided to pave first the section from A to B, 2 miles, then the 1½-mile section from C to B and finally the 2½-mile section from D to A. This gave, for the long haul, two miles of paved road.

Loading and Hauling.—Particular effort was made to eliminate delays in loading and hauling. Ford 1-ton trucks with Lee bodies were chosen to haul the dry batch, 15 cu.ft. of stone and 10 cu.ft. of sand, to a 21-cu.ft. paving mixer. To load these trucks without backing and without stopping was the object sought, and measuring hoppers, one for sand and one for stone, which would be discharged automatically by the truck were the means adopted. One partitioned bin, 10 x 10 x 20 ft., at the railroad siding held 40 cu.yd. in the proportions of three stone and two sand. As shown by Fig. 2, hinged chutes from the bins discharge into two measuring hoppers with swinging gates. A sketch of one of these hoppers is shown by Fig. 3. The only unusual detail is the lever arm, rivetted to the gate, which the passing truck body engages as shown by Fig. 2, and swings the gate open. The truck did not stop moving when taking a load but of course it moved very slowly, tripping the gates in succession. Trucks brought the sand from the washer and the stone came

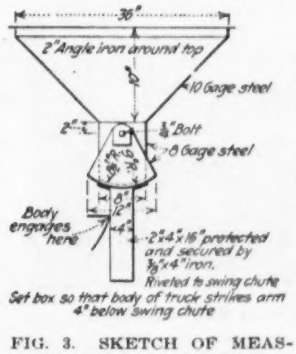

36"
2"Angle iron around top
10 Gage steel
2"
⅝"Bolt
8 Gage steel
Body engages here
2"x4"x16" protected and secured by ⅜"x4" iron. Riveted to swing chute
Set box so that body of truck strikes arm 4" below swing chute

FIG. 3. SKETCH OF MEASURING BOX-GATE TRIP

in by rail and both materials were handled at the bin by a locomotive crane and a ¾-cu.yd. clamshell. The operating force was a craneman and one man operating each of the bin chutes and two men in the cars.

On the long haul 16 trucks were operated; this number was gradually cut down to 3 trucks on the extreme short haul. One mechanic and assistant kept the cars in order, including tire repairs. One piece of equipment found very useful, was a Westinghouse locomotive type air pump and receiver installed at the bins to inflate the truck tires. It required an average of eight minutes from the time the truck entered the yard until it hauled out loaded. The trucks made over 20 miles an hour running light and about 15 miles an hour loaded. The grades were mostly 3 and 4 per cent with a maximum grade of 7 per cent. At the mixer it took a truck 30 seconds to turn on the turntable and 20 seconds to back up to the mixer and dump its load.

Sand Plant.—To wash the sand a portable crusher plant was remodeled by replacing the continuous bucket elevator with an intermittent bucket line and by installing a sand washer box of 200 tons capacity. Wash water was pumped from a brook 1,000 ft. away by a

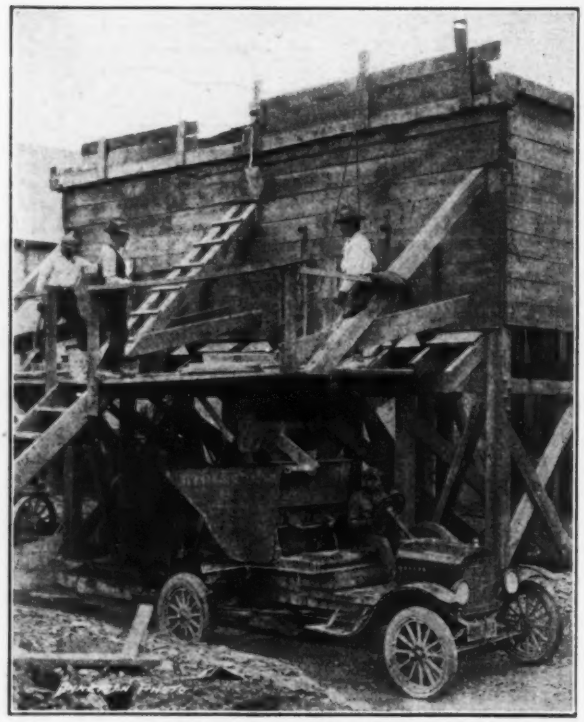


FIG. 2. MOVING TRUCK TRIPS HOPPER GATE

centrifugal pump, with 4 in. suction and 3 in. discharge, operated by belt from a Fordson tractor as shown by Fig. 4. The 3 in. line gave plenty of water for the required output of 150 tons a day. The sand was brought from the pit to the elevator by teams and slip scrapers because this outfit was available and unoccupied, but a drag line scraper outfit would, the contractor states, have been less expensive. The operating force was one foreman, one fireman, four laborers, one pump runner and three teams.

Paving Outfit.—A 21-cu.ft paving mixer, finishing machine, truck turntable and steel forms constituted the equipment on the grade. With the 21-cu.ft paver the output averaged 500 lin. ft. of 18 ft. 6-8-6-in. reinforced concrete pavement a day and reached a maximum of 561 ft. Cement was received in sacks and dumped directly into the mixer, using a five-bag batch.

FIG. 4. TRACTOR OPERATES CENTRIFUGAL PUMP

As the mix was 1:2:3, this gave five bags of cement, ten cubic feet of sand and fifteen cubic feet of stone to a batch. The cement was drawn to the road on a flat bottom truck and distributed in piles ahead of the mixer. The mixer crew consisted of two men handling the cement; one man handling the cement and dumping the trucks; a mixer operator and a fireman, and three men spreading concrete behind the mixer and placing steel reinforcing and expansion joints. The finisher required one operator, and there were two laborers to finish off the joints and the edge of the pavement. One man was used continuously to sprinkle water and in real hot weather two were required, one foreman and six men took care of the subgrade ahead of the mixer, while one foreman and ten men were required behind the mixer to move up the canvas, move up the forms and cover the concrete with dirt. The water for the concrete was furnished by two 3½-hp. engines; the supply was ample at all times.

The contractors were the H. B. Sproul Construction Co., Inc., Peekskill, N. Y., with H. M. Unangst as superintendent. H. D. Stoll, Scranton, Pa., was district engineer for the Pennsylvania Highway Department.

Road Building in Argentina

It is very probable that extensive road building will be undertaken in Argentina within the next two or three years, according to Commercial Attaché Edward F. Feely, at Buenos Aires. The Argentine Road Congress, to be held in Buenos Aires next May, will undoubtedly stimulate much interest, and it will be of advantage to American manufacturers of road-making machinery to watch closely the developments in Argentine road building.—*Commerce Reports.*

Second Railway Cantilever Bridge Over "Reversing Falls"

Canadian Pacific Completes New Crossing Alongside First Cantilever, Built 37 Years Ago—450-ft. Main Span

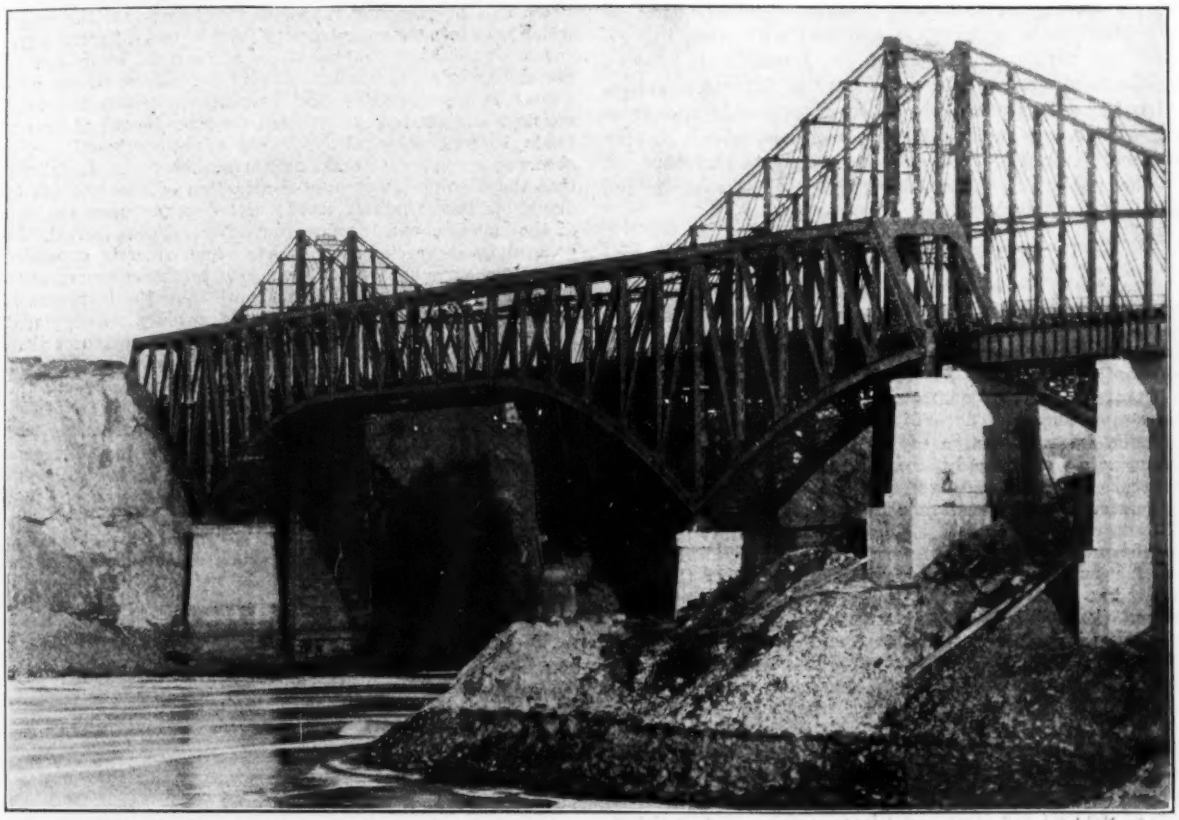
A NEW crossing over St. John River, St. John, N. B., has been completed by the Canadian Pacific Ry. It lies directly to the north of the first crossing, built in 1885, and like it is a cantilever bridge. These two structures, with the 565-ft. arch highway bridge built by the provincial government in 1915, form a cluster of three bridges spanning the St. John River at the narrowest portion of the gorge, close to the well known "Reversing Falls."

The older railway cantilever, at the rear in the accompanying view, originally was part of the undertaking of the St. John Bridge & Railway Extension, formed to connect the Inter-Colonial Ry. at St. John with the St. John & Maine Ry. at Fairville. In 1905 this connecting line was incorporated in the Canadian Pacific Ry. system.

The new cantilever has a main span of 450 ft. (as against 477 ft. for the old bridge); its underclearance is 2 ft. 7 in. greater than that of the old, on the length of the suspended span. As may be seen from the photograph its design differs from that of the old in having a horizontal top chord throughout, and parabolic curves for the bottom chords of the anchor and cantilever arms, while the old bridge has a horizontal bottom chord and inclined rectilinear top chords. The old bridge is pin-connected while the new one is riveted.

The main or cantilever portion of the new crossing is 700 ft. long, comprising two anchor arms of 125 ft., cantilever arms of 150 ft. each and a suspended span of 150 ft. Its steel weight is 2,000 tons. On the west or Fairville side is an approach consisting of eight plate-girder deck spans, each 70 ft. long out to out of steel.

Heavy steel members of I-section with enlarged bases resting on grillages, all imbedded in concrete, form the anchors of the cantilever. At the east end, excavation in solid rock was required for the anchorage, while at the west end a concrete pier was built. The anchor members were placed in shafts molded in this pier and subsequently embedded in concrete.



NEW AND OLD CANTILEVER BRIDGES OVER REVERSING FALLS, ST. JOHN, N. B.; CANADIAN PACIFIC RY.
Although of almost the same span, 450 ft. as against 477 ft., the two structures are markedly different both in outline and in make-up of members; the differences reflect the advance of bridge engineering skill in 37 years.

Solid rock projects below low water level from the river banks and forms shelves on which the main piers were founded. The piers, of concrete, are faced with granite up to high water elevation. The finish about 43 ft. above the surface of slack water.

Construction work was begun in April, 1920. By the following December the substructure was completed. Steel erection began in June, 1921 and was completed in October. On November 23 the bridge was opened to traffic. All the work was done under the general supervision of J. M. R. Fairbairn, chief engineer of the Canadian Pacific Ry. Co., P. B. Motley being engineer of bridges and C. F. Draper resident engineer on the work. The Foundation Co., Ltd., was contractor for the substructure, and the Dominion Bridge Co., Ltd., was contractor for the fabrication and erection of the steelwork.

Effects of Moisture on Behavior of Concrete

Tests Show How Plain and Reinforced Concrete Change in Volume Under Varying Conditions of Wetness

UNDER the title "A Study of the Effect of Moisture Content Upon the Expansion and Contraction of Plain and Reinforced Concrete" by Torata Matsumoto, the Department of Theoretical and Applied Mechanics of the University of Illinois has published a bulletin (Bulletin No. 126, Engineering Experiment Station) giving mainly the results of a series of experiments by Mr. Matsumoto, a Japanese engineer with some experience in harbor construction in Japan and later a graduate student at the University of Illinois, together with the deductions from these experiments and from experience, all setting forth some conclusions on the volume changes in concrete due mainly to moisture.

The purpose of the bulletin is well stated in the preliminary paragraph as follows:

To Investigate Internal Stresses

Purposes of Tests.—While the properties of concrete have been investigated for many years, attention has largely been given to considerations of strength alone. Studies of the less important properties, however, are also needed to explain phenomena that are observed in reinforced-concrete structures, and to give information on questions relating to the appearance and durability of the material.

Aside from the action of direct load, deformations are produced in concrete by changes in temperature and in moisture content. With reference to temperature changes in reinforced concrete, it is well known that, regardless of differences in the mixture, concrete has practically the same co-efficient of expansion as steel, so that the two materials contract or expand together. Moisture content, on the other hand, has the undesirable property of affecting concrete alone. Concrete, like wood, clay, and some other materials, expands when it absorbs moisture and contracts when it is dried; steel has no such action. After the concrete is poured the steel remains unchanged with changes in moisture conditions, while concrete ordinarily shrinks a considerable amount. Aside from the stresses set up in steel and concrete by the shrinkage of the latter, the resulting formation of cracks large or small will produce a condition which may be favorable to the corrosion of the steel or the disintegration of the concrete after repeated changes from dry to wet condition.

The tests which are described were made to investigate the amount of shrinkage which may be expected in a mortar or a concrete, the relation between the change of moisture content and the change of length of these materials, the difference in shrinkage of plain and reinforced concrete, and the internal stresses set up in the latter.

Tests were made on mortar and plain and reinforced-concrete pieces of acceptable material in different mixes and under different conditions of service.

The coefficient of expansion of mortar and concrete was measured for use in making a temperature correction of measurements. It was obtained from perfectly dried specimens only, so that there was no error due to the change in length with a change in moisture content of a specimen. The results obtained indicate that the coefficient of expansion of mortar and concrete is practically the same for different proportions and ages, provided that the same materials are used in all mixtures. The average values of the coefficient of expansion of 1:1, 1:2, and 1:3 mortar, and 1:1:2, 1:2:4, and 1:3:6 concrete, varied from 0.0000050 to 0.0000058 for one degree Fahrenheit, with no particular variation with the age or with the richness of the mixture.

Effect on Length of Specimen.—In investigating the effect of moisture content on the length of specimens, pieces 2 x 3 x 24 in. containing gaged steel plugs were made of different mixtures and subjected to different conditions of moisture storage. The deductions are as follows:

The amounts of change of moisture and length during the test are shown in the accompanying table. 1:1 mortar at seventy days contracted 0.025 per cent, notwithstanding the fact that it contained more moisture than its initial amount. From this phenomenon it can be concluded that the water which goes into the concrete may exist in two different ways, either combined with cement in a chemical compound or remaining in a state which affects the volume of the concrete. It also appears that concrete in which the total moisture content is kept constant for some length of time is liable to contract slightly. This slight contraction was observed on several occasions during the test. It follows that the absolute amount of contraction of concrete due to drying is indeterminate, because it depends upon the age of the concrete and the duration of the drying period. In general these specimens of mortar and concrete expanded when they were kept wet. The richer mixtures absorb more water and consequently expand more than the leaner ones. Mortar and concrete lose moisture rapidly when placed in dry air and the loss is more rapid in lean mixtures than in rich ones. In air storage the shrinkage is greater for mortar than for concrete, and with artificial drying the shrinkage is greater for the richer mixtures.

For the specimens tested, the contraction of mortar and concrete at a temperature of 150 deg. F., was 0.12 per cent for 1:1 mortar, 0.10 per cent for 1:2 mortar, 0.09 per cent for 1:3 mortar, 0.07 per cent for 1:1:2 concrete, 0.06 per cent for 1:2:4 concrete, and 0.06 per cent for 1:3:6 concrete. The amount of expansion when specimens were kept wet reached 0.012 per cent in 1:1 mortar, and 0.002 per cent in 1:3:6 concrete, at the end of 60 days. Judging from these tests, shrinkage of concrete in a structure freely exposed to the air may be as much as 0.05 per cent in a 1:2:4 concrete. In a structure such as a retaining wall or a road pavement, where one side of the structure is against a mass of earth, the shrinkage should be considerably less.

Rates of Absorption and Expansion

Phenomena of Volume Change.—From a further test the following deductions were made:

(a) Dry mortar and concrete expand as soon as they absorb water.

(b) The rate of absorption upon immersion is much less for the older specimens during the first two or three days of immersion, although the total amount of absorption does not change very greatly for specimens of different ages.

(c) The rate of expansion due to immersion is also less for the older specimens during the first two or three days of immersion. For longer periods of time the amount of expansion is nearly the same for all ages of each material; but in every case the expansion is considerably greater for mortar than it is for concrete.

(d) The amount of the expansion of mortar and concrete is small until an absorption of nearly 2 per cent is reached. After this point the expansion becomes nearly proportional to the addtional absorption of moisture. This holds true until a sudden decrease in the absorption occurs after one day's immersion, beyond which point additional absorption gives a greatly increased expansion.

(e) The absorption of moisture by mortar or concrete is much more rapid than the drying out of moisture from the same material. As a result, the expansion due to wetting is more rapid than the contraction produced by drying. For example, a mortar 7 days old gained as much moisture in 2 hours' immersion as could be dried out by heating to 150 deg F. for 24 hours.

Another experiment on the relation between absorption of moisture and expansion of concrete was made upon two specimens of 1:2:4 gravel concrete taken from a floor of the Western Newspaper Union Building in Chicago. The concrete was 9 years old. The sizes of the test pieces were 3.5 x 5 x 21 in., and 3.5 x 5 x 26 in. The specimens were dried for 13 days in an oven at a temperature of 150 deg. F. In drying, the average contraction of the concrete was 0.016 per cent for the two specimens. After immersion in water for 15 days the average absorption was 5.09 per cent and the resulting expansion 0.042 per cent.

Final Conclusions.—The bulletin then gives an analysis of the shrinkage stresses in reinforced concrete and a comparison of the calculated and measures stresses in some test pieces based on the experiments

TABLE SHOWING CHANGE IN MOISTURE CONTENT AND CORRESPONDING CHANGES IN LENGTH

Expansion and Contraction are given in Per Cent of Gage Length

	Kept in Wet Condition 60 Days		Kept in Air of Room 58 Days		Kept in Oven at 150 Deg. F. 14 Days		Dried in Oven at 200 Deg. F. 15 Days	
Proportion	Gain of Moisture Per Cent	Expansion Per Cent	Loss of Moisture Per Cent	Contraction Per Cent	Loss of Moisture Per Cent	Contraction Per Cent	Loss of Moisture Per Cent	Contraction Per Cent
1:1	1.46	0.0124	0.26	0.0460	3.92	0.1204	4.54	0.1570
1:2	1.14	0.0100	0.71	0.0488	3.51	0.0991	3.97	0.1237
1:3	1.05	0.0101	0.57	0.0503	4.04	0.0944	4.18	0.1077
1:1:2	0.85	0.0091	0.68	0.0358	2.86	0.0673	3.33	0.0807
1:2:4	0.89	0.0055	1.25	0.0333	2.80	0.0605	2.82	0.0636
1:3:6	0.64	0.0019	1.91	0.0362	3.21	0.0576	3.17	0.0622

and the theoretical deductions. As a general conclusion to the whole bulletin these comments are offered:

1. Concrete expands when it absorbs moisture and contracts when it is dried. Concrete of a 1:2:4 mixture is likely to contract during hardening as much as 0.05 per cent in an ordinary structure.

2. Contraction of concrete by the loss of moisture causes stress in the concrete when it is restrained by an external force. The amount of this stress is not as small as it is generally supposed.

3. The shrinkage stress caused in the steel in reinforced concrete may reach the usually accepted working stress of steel when the amount of reinforcement is less than 1.5 per cent.

4. The shrinkage stress developed in 1:2:4 concrete may reach the ultimate tensile strength of the concrete when the amount of reinforcement is greater than 1.5 per cent. With richer mixtures the increase in shrinkage stress may be relatively greater than the increase in ultimate strength.

5. The greater the percentage of reinforcement the greater the tensile stress that may develop in the concrete and concrete having a higher percentage of reinforcement than 1.5 per cent is likely to have cracks formed unless proper provision is made.

6. In reinforced concrete out of doors, subject to alternate wet and dry conditions, cracks may readily be formed under the repeated stress which is nearly equal to the tensile strength of the concrete.

7. Reinforced concrete does not appear likely to be a durable material in a place where a corrosive influence on steel, such as sea air, is active, unless proper protection against the formation of shrinkage cracks is made.

8. It is suggested that the prevention of shrinkage stress in concrete might be accomplished in two ways, either by finding a cement giving less expansion and contraction, or by the use of a perfect waterproofing treatment.

9. It may be expected that an integral waterproofing compound might lessen the change of volume for a short time, but it would not prevent the final diffusion of moisture with consequent change in volume.

Reciprocity in State Licensing Laws

Arbitrary boundaries restricting the activities of practising engineers have been established, though largely without intent, by the utter lack of uniformity in state laws for the licensing or registration of engineers. This aspect of the licensing problem was presented at the recent A. A. E. conference of practising engineers in a paper by C. S. Hammatt, secretary of the Florida board of engineering examiners and chairman of the National Council of State Boards of Engineering Examiners; an abstract follows:

No Reciprocity Now—State reciprocity for practising engineers with licenses does not exist at the present time, although the various states in passing their registration laws have aimed to provide for it. Every state has legislated differently in the matter of registration, yet each asserts that reciprocity for engineers is to be effective providing the standard is not lower in the other states. Such a provision is not practically in force, even in those ten states which have become members of the National Council of State Boards of Engineering Examiners, and such a condition cannot exist until this council can agree upon a uniform standard of requirements, which as yet has not been done. After such a standard has been agreed upon, those states which adopt it may reap the benefit of the intention of the laws. We will thus have two classifications of registered engineers: Those who practise within their own states and those who can practise in any state, upon paying the fee and filing their papers.

To Unify Procedure—Since all the states have different laws, it is difficult to see how the several state boards of engineering examiners can administer the clause for reciprocity without some change in the laws upon a uniform basis, or by an interpretation guided by a standard agreed to by the several boards. This problem resulted in the organization of the Council of State Boards of Engineering Examiners in the hope that it would be able to unify a procedure that would accomplish the aim of the several laws which provide for reciprocal relation. It is useless to expect the passing of a uniform code by the several state legislatures, but as the standard of requirement for registration is left largely to the discretion of the several boards, it would seem feasible for those boards to unite upon a common level and provide for a standard that would be acceptable to all for the reciprocal interchange of registration. A qualification for reciprocal registration that would be accepted by all the states must start with a standard as high as that prescribed by the most exacting of all the laws, and it should be such as would command the respect and approval of all skilled and educated men in the profession. To bring this about appears to be an easy matter through the council. It can provide a uniform code, which, if agreed to by the various state boards, can become operative by the attachment to certificates issued by the state boards of an additional seal bearing the words "reciprocal registration."

Some states require two, four or six years' experience; others exact ten years. The uniform code should call for the maximum time exacted by any of the states and should commence the calculation of that period with duties above those of apprenticeship, foremanship or inspector, and with those of civil engineers whose experience is not less than that of actual instrumentman, unless such duties were shown to be of a very responsible character. The showing of work performed, under what authority vested, for whom and when, in the statement of experience should be carefully scrutinized and only such credit given for reciprocal registration as would be, beyond question, fully qualifying. This would provide requirements of sufficiently high character and reliability that no question might be raised as to the integrity of the statement. The National Council of State Boards of Engineering Examiners, next October, will no doubt provide a basis such as the one outlined to those engineers coming from other states whose boards have put their stamp of approval upon their qualifications.

Field Experiments on a Practical Irrigation Rating Box

By C. C. Jacob
Federal Court Commissioner for the Uintah Basin, Utah, and
H. R. Leach
Junior Engineer, U. S. Irrigation Service (Resigned)

THE disadvantages of a standard weir for measuring irrigation water are well known. In silt laden waters the rapidity with which such a weir silts up renders it useless as a practical device for the measurement of water. Various modifications of the standard rectangular weir have been proposed from time to time with the idea of avoiding these disadvantages and obtaining a measuring device simple of construction and operation and sufficiently accurate for practical work. The most promising of these modified weirs thus far suggested is that described by V. M. Cone as "A New Irrigation Weir" (*Journal of Agricultural Research*, March 13, 1916, and *Engineering News*, Aug. 3, 1916) which, in its elemental form, is a rectangular weir with the bottom contraction suppressed. Among the advantages claimed from this modification are: (1) it is simpler of construction and of smaller dimension than the standard weir; (2) it is self cleaning; (3) it can be installed where the available head is less than required for the installation of a standard weir.

In connection with their work of distributing water under the various canal systems of the Uintah Basin the writers found it necessary to modify some of the rating flumes on certain of the main canals to prevent the continuous shifting of their ratings due to the accumulation of sand and gravel above or below the flumes. This was accomplished by throttling the flow through the flume at the lower end by means of wings projecting into the flume at right angles to the sides, the opening between the wings being in general one-half of the original width of the flume. The results obtained from these modified flumes were very satisfactory. The shape of the rating curves was much improved and the ratings were apparently permanent. These results, together with the Cone experiments referred to, indicated that a simple and cheap measuring box designed on this principle could be constructed of native lumber and operated successfully in the silt laden canals of the Uintah Basin. A number of small boxes were installed on various laterals and the field ratings verified these conclusions, for, while the boxes were installed under various conditions of velocity of approach, the ratings consistently showed a definite law of flow.

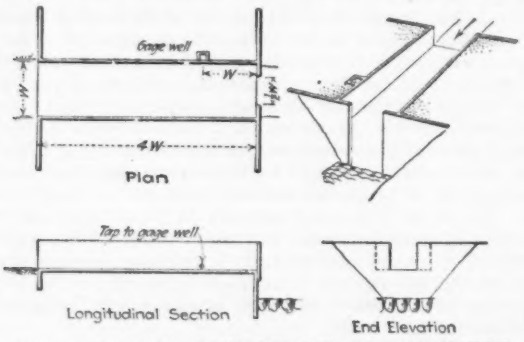


FIG. 1. RELATIVE DIMENSIONS OF RATING BOX

These results led to the permanent adoption of the box in the form shown in Fig. 1. It is a simple rectangular flume of a length four times its width, contracted at its lower end to 50 per cent of its width. It is designed to have a free overfall at this end similar to an irrigation drop, but experiment shows that a slight submergence of the notch does not affect the head discharge relation. Rough lumber was used for all boxes owing to the excessive cost of any other available material. The floor of the box is level and the head is measured a distance equal to the width of the box upstream from the notch.

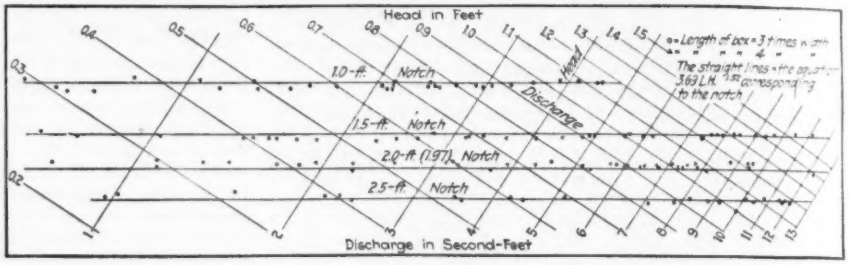


FIG. 2. COMPARISON OF OBSERVED VALUES, RATING BOX EXPERIMENTS: $Q = 3.69\ LH^{1.82}$

In order to accurately rate the box and determine the formula for discharge through it, a field laboratory was set up under authorization of A. J. Charles, project engineer, Uintah Irrigation Project. This consisted of a 90-deg. V-notch weir by which the discharge could be measured, a flume with a 2-ft. drop near its lower end in which the experimental boxes could be built, and a gate below this drop by means of which the notch could be submerged and the effects of submergence studied. Heads were measured in stilling wells with hook gages. Four different boxes were rated whose nominal widths were 2, 3, 4 and 5 ft. respectively, the width of the notch or opening being one half the width of the box in each case. The boxes were constructed of unfinished lumber, the notches being formed at the 2-ft. drop by nailing 2-in. planks on the end of the box, edges vertical, each overlapping the end of the box one-fourth the box width. The floor of the box was level and the sides vertical. The notches were square-edged but not bevelled.

The head on the V-notch was measured on a hook gage and the discharge of the notch computed by King's formula. Simultaneous readings of the gages were made for each observation and the flow through the set-up kept constant during the interval. The observed data are given in the accompanying table.

For the determination of the formula of flow the data were plotted by logarithmic co-ordinates, Fig. 2, straight-line graphs resulting. Each size of box gave a different slope and intercept, showing the discharge to be not strictly proportional to the width of the notch. It was found possible, however, to adjust a single line to all experiments and still keep within the practical limit of error. This line is represented by the equation, $Q = 3.69\ LH,^{1.82}$ in which Q is the discharge in second-feet, L, the width of the notch in feet, and H, the head on the notch measured a distance equal to the width of the box above the notch. A rough equation for field use,

easy to remember and also to compute is $Q = 3.7\ LH^{3/2}$.

Observations were also made to study the effect of various modifications of the standard entrance condition on the rating of the box, and to determine the effect of submergence of the notch by tail-water. The results show that considerable interference with the free entrance of water into the box is permissible with only a slight error in the discharge. A submergence of the notch up to 0.2 ft. has no practical effect on the box rating. Conclusions drawn from all of the experiments may be summarized as follows:

1. The formula, $Q = 3.69\ LH,^{1.50}$ gives the discharge of the box up to a head equal to the width of the notch.

2. In only 5 of the 134 observations made under standard conditions, do the discharges computed by the formula differ from the observed discharges by more than 0.10 second-feet.

3. Metal and wood contractions give the same rating.

4. No difference in the rating of boxes of a length either 3 or 4 times the width could be detected in the cases of the 2- and 3-ft. boxes. In the case of the 4-ft. box the discharge was somewhat lower for the short box.

5. A slight change in the ratio of notch width to box width does not materially affect the rating.

6. Submergence decreases the discharge but it requires a submergence of 25 per cent of the head to decrease the apparent discharge 5 per cent.

7. It requires material obstruction at the entrance to appreciably change the rating.

A great many of these boxes have been installed in the Uintah Basin during the past three seasons, replacing, in many instances, Cippoletti weirs which it was impossible to maintain, and their use has solved a troublesome problem in the task of distribution of water.

OBSERVED HEADS AND COMPUTED DISCHARGES, RATING BOX EXPERIMENTS.

2-Ft. Box (Notch 1 ft.)			3-Ft. Box (Notch 1.50-ft.)			4-Ft. Box (Notch 1.97-ft.)			5-Ft. Box (Notch 2.50-ft.)		
H_e	Q	H	H_e	Q	H	H_e	Q	H	H_e	Q	H
Length 6.0-ft.			Length 12.0-ft.			Length 12.0-ft.			Length 16.0-ft.		
0.28	0.11	0.105	1.70	9.35	1.41	1.575	7.74	1.07	1.775	10.46	1.08
0.54	0.55	0.29	1.63	8.41	1.32	1.52	7.09	1.01	1.85	11.09	1.16
0.58	0.66	0.31	1.595	7.98	1.27	1.45	6.31	0.96	1.86	11.68	1.17
0.57	0.63	0.305	1.57	7.68	1.24	1.40	5.79	0.88	1.88	11.90	1.18
0.725	1.12	0.45	1.55	7.44	1.21	1.27	4.55	0.76	1.85	11.49	1.16
0.805	1.48	0.65	1.51	6.97	1.165	1.10	3.19	0.60	1.80	10.72	1.12
0.93	2.11	0.675	1.39	5.68	1.02	0.88	1.84	0.41	1.75	10.03	1.065
0.935	2.14	0.70	1.32	5.00	0.93	0.85	1.69	0.39	1.69	9.21	0.99
0.995	2.49	0.76	1.26	4.46	0.855	0.61	0.74	0.23	1.66	8.79	0.97
0.985	2.43	0.75	1.21	4.04	0.80	1.645	8.61	1.16	1.61	8.16	0.93
1.07	2.98	0.85	1.16	3.64	0.74	1.70	9.35	1.22	1.58	7.80	0.885
1.145	3.52	0.97	1.095	3.15	0.68	1.71	9.49	1.23	1.52	7.09	0.83
1.225	4.16	1.09	1.04	2.78	0.635	1.655	8.75	1.17	1.34	5.19	0.69
1.26	4.46	1.13	0.99	2.46	0.60	Length 16.0-ft.			1.26	4.46	0.62
1.11	3.26	0.915	0.88	1.84	0.47	1.71	9.49	1.20	1.235	4.25	0.605
1.025	2.68	0.80	0.80	1.45	0.41	1.61	8.16	1.10	1.15	3.56	0.535
0.92	2.05	0.67	0.79	1.41	0.40	1.555	7.50	1.04	1.14	3.48	0.530
0.825	1.57	0.565	0.695	1.03	0.33	1.55	7.44	1.02	0.98	2.40	0.41
0.76	1.28	0.50	0.58	0.66	0.25	1.495	6.80	0.965	0.96	2.28	0.405
0.635	0.82	0.38	0.485	0.42	1.195	1.425	6.04	0.90	0.94	2.16	0.39
0.525	0.51	0.27	0.445	0.3	0.17	1.42	5.99	0.89	0.82	1.54	0.32
Length 8.0-ft.			0.83	1.58	0.43	1.335	5.15	0.805	0.69	1.01	0.24
0.405	0.27	0.18	0.96	2.28	0.54	1.245	4.3	0.72	0.68	0.97	0.23
0.605	0.73	0.33	1.10	3.17	0.685	1.195	3.91	0.675	0.55	0.58	0.17
0.77	1.32	0.495	1.21	4.03	0.80	1.09	3.12	0.59	1.55	7.44	0.87
0.86	1.74	0.60	1.30	4.82	0.90	1.01	2.58	0.52	1.40	5.79	0.74
0.935	2.14	0.68	1.38	5.58	1.00	0.90	1.94	0.43	1.11	3.26	0.51
0.94	2.16	0.69	1.44	6.20	1.07	0.79	1.41	0.35			
1.00	2.52	0.76	1.55	7.44	1.20	0.715	1.10	0.29			
1.08	3.05	0.87	1.45	6.31	1.08	0.595	0.70	0.23			
1.19	3.87	1.04	0.885	1.86	0.485	1.17	3.71	0.64			
1.265	4.50	1.14	Length 9.0-ft			0.955	2.25	0.46			
1.055	2.88	0.84	1.83	11.20	1.60	1.35	5.29	0.81			
0.94	2.16	0.70	1.78	10.47	1.53	Metal Contractions					
0.70	1.04	0.44	1.725	9.68	1.445	1.695	9.28	1.20			
			1.675	9.01	.38	1.61	8.16	1.10			
			1.62	8.28	1.31	1.58	7.80	1.06			
			1.58	7.80	1.255	1.54	7.34	1.01			
			1.42	5.99	1.04	1.455	6.37	0.925			
			1.31	4.91	0.92	1.49	6.75	0.96			
			1.12	3.34	0.71	1.46	6.42	0.935			
			0.99	2.46	0.57	1.39	5.68	0.87			
			0.82	1.54	0.42	1.27	4.55	0.76			
			0.615	0.76	0.27	1.11	3.26	0.60			
			0.855	1.71	0.45	0.95	2.22	0.47			
			1.02	2.65	0.60	0.76	1.28	0.33			
						0.71	1.08	0.30			

H_e = Head on V-notch weir
Q = Discharge over V-notch by King's formula: $Q = 2.52\ H_e^{2.47}$
H = Observed Head on rating box

New Department of Surveying at University of Michigan

A separate diploma department of geodesy and surveying, distinct from but connected with the engineering department, was authorized in December, 1921, by the engineering college of the University of Michigan. This action was based on the conclusion that the proper schooling of the surveyor requires much more time than that allotted to surveying in the regular civil engineering course. This new system was described at the recent annual meeting of the Illinois Society of Engineers, by Thomas J. Mitchell, assistant professor of surveying at the University of Michigan, who stated that the definite field of surveying has been almost entirely neglected by engineering schools. The following is a brief abstract of Mr. Mitchell's paper:

When we compare American with European practice, we become impressed with the gap that our universities have allowed to develop. In almost every civilized country, surveying in its broadest significance is considered an important and high class profession interested in the application of science to its problems. In many places in Europe separate schools are maintained for the study and research of geodesy, a branch of surveying. Apparently the European idea is that surveying is a separate profession not intimately connected with engineering, but that its practitioners rank equal to or higher than engineers.

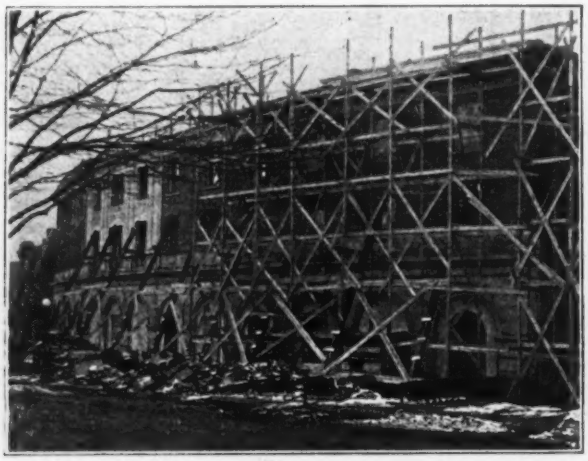
The present demands for men with such a training as it is purposed to give, are many and definite. Massachusetts is engaged in a resurvey and some counties in Michigan are planning resurveys. The work of the General Land Office has been completely reformed. There is a demand for men qualified by training to assume leadership. The science of geodesy has been largely confined to such federal departments as were able to train their own men. Now many of our cities have reached such a size that surveys on plane co-ordinates are inadequate and misleading. Business interests are yearly becoming more insistent in their demands for complete topographic maps of the nation. It will be necessary to train men to occupy this field and this training seems to be a public service obligatory on the universities. Already demands for special short courses have been made by practicing surveyors.

Two Committees Charge Knickerbocker Collapse To Twisting Failure Of Truss End

Substantially identical conclusions as to the cause of the great Washington theater disaster of Jan. 28 have been reached by two independent investigating bodies: a committee of the Washington chapter of the American Association of Engineers, and a board appointed by the Associated General Contractors. The reports submitted by these committees are summarized below, in greatly condensed form. The results of the official investigation, carried out for the District Attorney by a board of engineers of the War and Navy departments, have not yet been made public, but it is known that the board attributed the roof collapse to the failure of a minor beam support—the wall bearing of purlin 21. In disagreement with this view, the two reports here presented find that the north end of the main truss failed by twisting due to defective design. This part of the truss was on the verge of failure before the collapse; the added snow load in the heavy storm of Jan. 28 was the last straw.

Discussing the question of responsibility for this vital defect and others almost as serious, the two reports place the blame on the architect and the steel fabricator, the latter having prepared the design of the framework. Emphasis is placed on the fact that municipal approval of plans and inspection of work does not relieve the architect of full responsibility for adequacy and safety of his structures.

TWO organizations, the Washington chapter of the American Association of Engineers and the Associated General Contractors, have been at work for six weeks past investigating the Knickerbocker moving-picture theater roof collapse in Washington on Jan. 28. The investigations were completed and reports presented within the past two weeks. While they diverge considerably in detail, their findings of cause are substantially identical: twisting failure of the north end of the main truss, due to defective design. The A. G. C. committee shows, moreover, that other explanations or findings of cause are untenable and in conflict with fact.



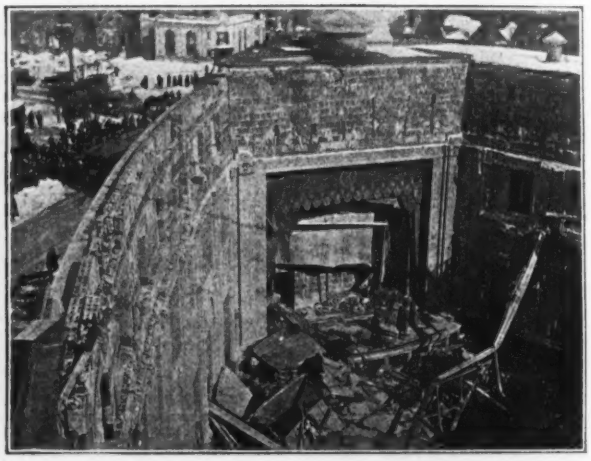


FIG. 1. KNICKERBOCKER THEATER: WALL CONSTRUCTION CRITICISED BY CONTRACTORS' COMMITTEE

Curved bearing wall on Columbia Road side of auditorium. This wall was cut up by many window openings, intended for exterior effect. At the light-colored portion of the wall the main roof truss was seated, bringing to bear a concentrated load of more than 50 tons. The wall at this point was found 5 in. out of plumb after the accident.

Interior view. The 55-ton truss load was carried on the hollow-tile wall at the left. The proscenium wall in the background contains at the top the seats of three roof beams, 22, 23 and 24, the first of which was charged in the expert testimony at the inquest with being one of the first members of the roof to fall.

Looking aside from the immediate cause and the events during the collapse, the A. A. E. committee also presents the results of an analysis of the structure, listing the defects of design and the numerous divergences from building law requirements. The conditions found are such, according to both reports, as to have made failure of the structure almost inevitable at some time, by reason of some combination of the defects, even if the particular failure of Jan. 28 had not then occurred.

Both reports take up quite specifically the question of professional responsibility. They place primary blame on the architect. The A. G. C. board exculpates the contractor, while the A. A. E. committee holds that he might have been expected to discover the faults of the structure. Both indicate that building supervision and inspection should not be expected to discover and prevent all the faults or remedy the defects in design resulting from inadequate performance of the architect's function. Registration of architects, engineers, and builders with the local building department, with penalty of suspension or revocation, is recommended by the A. G. C. committee, in line with recommendations made some years ago by the New York Building Department.

The investigation for the Associated General Contractors was carried on by Rudolph P. Miller, former superintendent of the Building Department of Manhattan,

New York City; James Baird, vice-president of George A. Fuller Co., Washington; Guy Mason, attorney, Washington; W. P. Christie, research engineer of the A. G. C. The committee of the Washington Chapter of the American Association of Engineers consisted of Nolan D. Mitchell, W. G. Noll, L. M. Neel, W. A. Slater, J. A. Cliff.

General Facts—For the general facts of the construction of the building and of its collapse reference may be made to *Engineering News-Record* of Feb. 2 and Feb. 9. Briefly stated, the theater, which was built in the early part of 1917 and was opened in the summer of that year, was of roughly triangular shape and was roofed with a 3-in. concrete slab carried by I-beams spaced 9½ ft. apart and resting on a framework of trusses. The main supports were two interior columns (there were also two short balcony columns) and the walls themselves (see plan, Fig. 2). The truss supports on the walls were nearly 40 ft. above ground. The walls themselves were of hollow tile (with vertical cells), except the south wall, which was of brick. The curved wall along Columbia Road, which is of primary interest, was 22 in. thick, composed of 18 in. of tile and 4 in. of facing brick and limestone. The entire roof of the seating space fell during a performance on Jan. 28, when a heavy snowstorm was raging and some 24 in. of snow had already fallen. While the seating capacity was over 1,800, only about 300 spectators were in the theater; of these 97 were killed and more than 100 were injured.

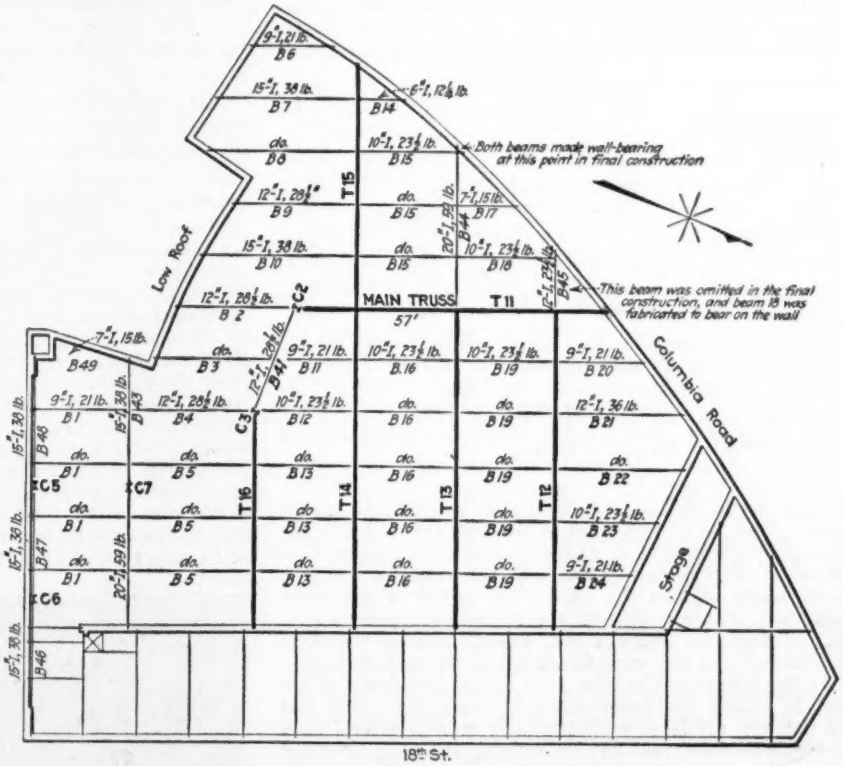


FIG. 2. KNICKERBOCKER ROOF FRAMING

Various engineers have charged the failure to bending or buckling of beam 41, between column C2 and C3, to failure of the wall seat of beam 21 pulling beam 22 off its seat with the result that truss T12 buckled, and to breaking of the roof slab between beams 21 and 22 with the same result. The A. A. E. and A. G. C. reports find that the main truss, T11, failed at its wall end and twisted off its seat, due to defective design.

How the Roof Failed—From study of the wreckage, the American Association of Engineers' committee finds the explanation of the collapse in the following sequence of events:

Under the normal loading of truss T11, there would have been sufficient deflection to cause the lower chord of the truss to twist slightly at its point of support in order that a bearing be secured by both channels of the lower chord. This twist would put a bend in the ½-in. gusset plate which formed the only connection between the lower chord and the end post. The eccentricity thus set up may have been increased by contraction of the truss due to changes in temperature, or by any tendency of the wall support to move outward. It is not only possible but very probable that such a tendency existed. Any local settlement of the footings under the points where the loads were concentrated would, on account of the curvature of the wall, have the effect of throwing the top of the wall outward. Another possible factor may have been the inclination of the roof near the support of truss T11, which would cause a large outward thrust of the wall when either the main truss or purlins 20 and 21 deflected.

With the gusset plate between the end post and the lower chord of truss T11 already stressed nearly to its yield point, the very slight additional load of snow probably was sufficient to bend it to such an extent that the end of the truss was thrown completely off its seat, not by slipping but by the buckling of the gusset plate and the twisting of the lower chord of the truss until it rolled off the I-beam seat, thus precipitating the failure of the entire roof by dragging all the other trusses with it.

As the roof started to fall at the north end, it apparently pivoted about a horizontal axis approximately east and west through the top of the angle strut over column C2, while the top of the column moved toward the south as the north end of the truss fell. At the same time a southerly motion was given to all parts of the roof as it fell. That the roof had such a motion during its fall is evident from the scoring of most of the seat beams supporting trusses T12, T13, T14 and T16 at the east (18th St.) wall and from the diagonal abrasion marks indicating where the walls were scraped by the ends of the falling trusses and purlins. This southerly motion was no doubt aided by an initial inclination of column C2, but the amount of this inclination (1 in. in the height of the column) could not have been sufficient to start the collapse.

End of Truss Crippled—The committee sketches the distortion of the end portion of the main truss, T11, prior to and during its unseating (Fig. 3). It explains the distorting effects thus:

On account of its skew bearing, it will be seen that the slope of the bottom chord (exaggerated in the sketch) due to the center deflection of the truss, caused an inclination of the top of the bottom chord toward the east, in order to bring the east channel of the two forming this chord into bearing upon the I-beam seat. As the actual deflection of truss T11 is not known, it is not possible to determine

just how great was the inclination of the channels. However, with a deflection of the truss of 1 in., the inclination of the bottom chord channels would cause a bending of the gusset plate producing an eccentricity e of nearly 0.1 in., under which the sum of the computed direct and bending stresses would be close to the yield of the steel. From independent sources, statements from workmen have been reported that after erection there was a deflection of the truss T11 of 3 or 4 in. The eccentricity e presumably would be proportional to the deflection of the truss, and the significance of such a deflection will be apparent. Under such critical conditions any other influence tending to increase the eccentricity would be almost certain to result in crippling of the gusset and lower chord of the truss. As it

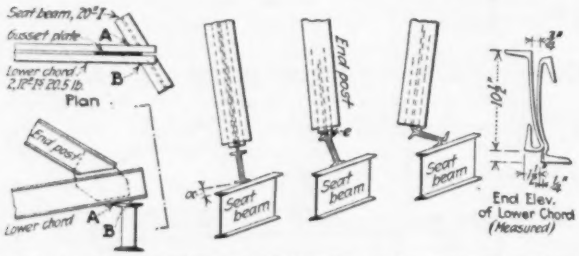


FIG. 3. DISTORTION CONDITIONS AT COLUMBIA ROAD (NORTH) END OF MAIN TRUSS T11

Sketched by A. A. E. Committee. The deflected position of the truss on its seating beam in the wall is sketched at the left to exaggerated scale. Following this, the deduced sequence of distortion is indicated. Sketch at right shows the present condition of the north end of the bottom chord.

actually occurred, the east flange on the bottom of the lower chord was bent upward against the web of the channel, while the west flange was not bent upward at all at the end. The upper flange on the west side was bent down nearly against the web. The corner of the cover plate was bent upward. If the truss had slipped off its seat it would be expected that the east flange would be undisturbed and the west flange would be bent upward.

All the phenomena together are almost positive evidence that in falling the lower chord of truss T11 rolled and did not slip (at least until the later stages) off its seat. Not only is this true, but an upward crimping of about ¼ in. which occurred in the west flange of the lower chord at approximately the edge of the bearing shows that there must have been an extremely heavy pressure at the point where the west channel bore upon the edge of the I-beam. This evidence of pressure is exactly what would be called for by the behavior just described, and is a strong indication that it occurred at the beginning of the failure and not as an aftereffect. It is not improbable, however, that the final stages of the crippling may have been completed only when the end of the truss struck the floor.

The evidence seems clear that truss T11 started to fall before beam 21 fell. At the point at which beam 21 framed into the top chord of truss T12, the north flange of that chord is buckled upward. Careful examination shows the marks of the web of beam 21 on the bottom of the flange, indicating quite clearly that as truss T11 fell, beam 21 acted as a lever prying the north flange of the top chord of the truss upward. Additional evidence is found in the fact that the gouge caused by the bearing of the web of the beam extends around the edge of the flange of the north angle and a short distance back from the edge on the top; this latter gouge apparently was caused by a small piece of metal which in coping beam 21 was left directly above the web of the beam. This gouging of the flange could have been caused only by truss T11 falling before purlin 21 fell.

Further evidence that the north end of the purlin did not fall before the south end fell is afforded by the movement of the proscenium wall to the north, due apparently to the thrust of the inclined purlins. This movement of the walls as measured under the roof slab over the stage was ¾ in. at the junction of the proscenium wall with the Columbia Road wall, 1½ in. at the beam seat for purlin 22, and ¼ in. at the seat for purlin 23. No movement was found at the seat for beam 24.

The committee concludes that the failure started at the north end of truss T11, from the causes set forth in the preceding paragraphs.

A. G. C. Board's Finding of Cause—Substantially the same sequence of events is found by the investigating board of the Associated General Contractors. This board states that the ½-in. gusset plate between end post and upper chord of the main truss, which furnished the only lateral stiffness of the heavy upper chord, buckled to the west, and the lower chord where it rested on the wall without reinforcement for bearing stresses and eccentricity was crushed and tilted under a combination of tension, compression and twisting stress. More specifically, the committee recites the conditions and actions thus:

The actual roof load greatly exceeded the design load; the main truss was reduced about 9 in. in depth from the original design, and its moment plates were neither butted together nor spliced. These factors all produced excessive downward deflection of that truss. This deflection, acting on the skew bearing, created a thrust at the Columbia Road wall which tended to push the wall outwardly and to twist the bottom chord of the truss. Either of these movements, occurring in but a small degree, was capable of unseating the truss, as its bearing perpendicular to the wall was only 6 in. and parallel to the bottom chord 8 in.

To resist this twisting force the only stiffness provided was that of a ½-in. gusset plate and of the bottom chord in the first panel. The batter post could contribute nothing, as its rigidity was in turn limited by a ½-in. gusset at its upper end. Thus, the bottom chord from the twist-

FIG. 4. WALL PLATE ON WHICH BEAM 22 WAS SEATED

Expert testimony at the inquest attributed the collapse to beam 22 being pulled off its wall seat laterally (to the left). According to the A. G. C. board the spilled cement which outlines the original position of the beam on the steel wall plate fails to show marks such as lateral sliding of the beam would have caused.

ing force alone was probably in a hazardous condition. Furthermore, the two 12-in. channels forming this member extended beyond the gusset plate with their webs unsupported, forming an eccentric bearing. These webs therefore took practically the full bearing load of the truss and the stress from its eccentric bearing as well as the twisting force. Under such a combination of stresses, failure in the bottom chord or bearing was at some time almost inevitable. A condition existed that would have been dangerous with a thoroughly adequate wall, and when with this was combined a thin wall badly cut up by openings, a condition must have existed which awaited but an

additional load, a measure of vibration, or fatigue of the overstressed metal, to result in a collapse.

The additional load and probably the vibration and fatigue were present when the roof gave way. A snow load of some 12 or 13 lb. per sq.ft., or about 16 per cent of the dead load (computed from precipitation recorded by the U. S. Weather Bureau), exclusive of possible drifting, and the heaviest since completion of the building, was on the

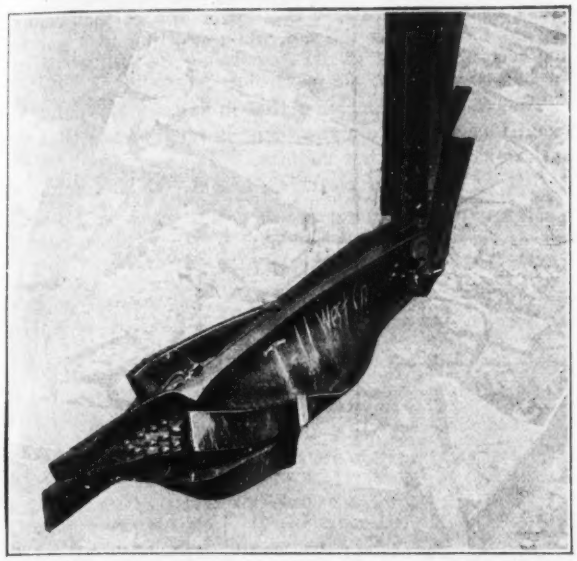


FIG. 5. TWISTED NORTH END OF BOTTOM CHORD OF MAIN TRUSS

The end piece of the truss has been placed in a vertical position, indicated by the web members at the first panel point. The end of the chord in the foreground is twisted more than 90 degrees, with its top flange forced down eastward. The ends of the 12-in. channels, which had no connection or staying for 8 in. from the end, carried a load of 55 tons when the truss was in service.

roof. Vibration from passing street cars had been noted on the structure and was doubtless accentuated at times by a double 8-ft. ventilating fan carried on the roof. The snow load which increased the dead load at the north end of the main truss some 15,000 lb. was, so to speak, the last straw in destroying equilibrium at the support. It undoubtedly provided the additional stress necessary either to buckle and twist the member resting on this bearing, or to buckle the gusset plate above.

When the web of the east channel of the bottom chord buckled, the top of that member (not the whole truss) was twisted eastward, thus unlining the batter post, and moving the center of stresses off the bearing. With the bottom chord in his condition only the lateral stiffness of the wall could prevent the truss from sliding off. This stiffness the wall did not have. It was pushed outward about 5 in.—sufficient to break both its bond with the stage wall, to break the stage wall itself, and to allow the truss to drop.

Whether the gusset plate or the bottom chord channel failed first is immaterial, as either action would have brought about the other and would have thrown the batter post out of line. Once this member was displaced, collapse readily followed.

No failure of an auxiliary truss was essential to unseat the main truss, and no failure of a beam, as they were actually erected, is believed to have been capable of causing a failure in the auxiliary truss T12. In no member of the steel, except the bottom chord mentioned, has any evidence of failure between supports and before falling been found. Collapse through a succession of preliminary failures seems highly improbable in view of the difficulty experienced in efforts to cause collapse when demolishing structures.

Official Explanations Untenable—A careful analysis of other theories of the failure is presented by the A. G. C. board. The first of these is the explanation offered by a board of army and navy engineers which served as investigating authority to the district attorney. This report attributed the failure to primary failure of the wall bearing under beam 21, by a combination of slipping off (after outward movement of the wall) and crushing of the tile. According to this theory this beam in falling pulled beam 22 sideways, westward, off its wall bearing; the two beams in falling broke the bolts by which they were fastened to the top chord of truss T12, and, this truss being thereby freed also from the opposite purlin beams, it buckled and fell, pulling the main truss off its wall support and dropping the entire roof.

The A. G. C. board finds this explanation incompatible with the facts. At wall bearing 22, cement which was spilled on the bearing plate at the time of construction was not disturbed along the west side of the beam, and a piece of tile projecting from the wall could not have remained in place had the beam moved westward. The sharp upward buckling of the top-chord flanges of truss T12 where the beams framed into it, and marks made on the under side of the top chord by these beams, "could have been made only by a scissors action from each pair of beams as the truss preceded them in its fall." A break in one flange of the top chord of T12 is described as a clear tension failure resulting from this scissors action. Moreover, "if beams 21 and 22 had dropped from their wall supports and broken their truss connections, the first sign of collapse should have been the appearance of their north ends as they broke through the ceiling. This, according to eye witnesses, did not take place."

Slab Failure Theory—A somewhat similar explanation by one army officer goes farther back and assumes that a breaking of the roof slab pulled beams 21 and 22 towards each other and off their supports. The board, however, finds that at this point the slab was probably stronger than elsewhere; that breaking of the

FIG. 6. NORTH BATTER POST OF MAIN TRUSS

At front, connection to top chord; the angles on the lower side of the gusset are the connection angles for the top chord of truss T12. There is no connection of the cover plates at the hip.

slab could not have pulled the beams toward each other; and that since in the southeast corner of the building a large slab of the roof is still holding together unsupported, the suggested action appears unlikely.

Column Failure Theory—A published article by a structural engineer charged the failure to bending of purlin 41 and crippling of the main roof column (C2). The column failing, presumably through overloading, it allowed the south end of the main truss to drop, pulling the north end from the wall. This explanation is rendered untenable by the fact, among others, that the

column underwent no distortion through the collapse.

Architect's Theory—According to the architect of the theater, a weakness in the steel of the top chord of truss T12, just where beam 22 was attached, caused the truss to buckle here, pushing the beams north of it into the stage wall, and thus allowing truss T12 to pull the main truss from its bearing. However, the stage wall shows no evidence of the beam having punched through the hollow tile at the beam end.

Gusset-Plate Failure Theory—One theory advanced places the origin of failure in the gusset plate connecting the top chord of the main truss with the north batter post. Buckling of the truss at this point caused the top of the post to move westward, thus throwing the main truss out of line and pulling truss T12 from its bearing in the east wall. The board finds that truss T12 did not fall early in the collapse, however.

Structure Had Many Weaknesses—A full review of the many weaknesses and defects of the structure is given by the A. A. E. committee. It finds that the roof slab, with a working stress of 16,000 lb. per sq.in. (the reinforcement had a yield-point of 73,000), had a total capacity, dead and live load, of only 23 lb. per sq.ft., while the actual load was about 75 lb. But no evidence was found in the wreckage that the slab failed until after the failure had started elsewhere.

Steelwork Overstressed and Unbraced—Inadequate proportioning, bad details and lack of bracing characterized the steel roof structure, the A. A. E. committee reports. The main roof truss was actually made 9 in. less in depth than the stress sheet shows, as the 6½-ft. designed depth was actually made the overall depth of the truss. The cover plates of its chords were not spliced or even butted, and as a result there was pronounced weakness with respect to buckling between the points where the lateral trusses were attached. Assuming no support of the top chord of the main truss by the roof slab, the slenderness ratio of the chord channels between these points was 184, and the allowable unit stress 4,510 lb. per sq.in., whereas the actual compression in the chord reached 20,000 lb. per sq.in., an overstress of 345 per cent. The lateral staying of the chord by the auxiliary trusses, moreover, depended entirely on the friction of these trusses on their wall bearings.

Other characteristic elements of weakness in the steel structure are described:

The gage lines of the inclined and the vertical web members always intersected at the inner flanges instead of at the center-of-gravity line of the chord channels. At each end of the main truss the first two diagonals were designed to carry the same total stresses, yet at their intersection with the bottom chord one of them was provided with twenty rivets and the other with only seven. The principal feature disclosed by the computations of the secondary trusses is that the rivets were apparently figured in double shear, regardless of the fact that their capacity was limited by their bearing value on the ⅜-in. gussets. Compression members of these trusses overstressed as much as 78 per cent had only one stitch rivet in panel lengths of 10 ft. The bracing of columns C2 and C3, which supported trusses T11 and T16, was very defective. Column C2 according to the original plan was entirely without bracing from the east or the west. This lack is reported to have been recognized by the architect during the erection of the roof, and a 10-in. 23½-lb. I-beam extending horizontally from the bottom chord of the main truss T11 to column C3 was added. Its connection to column C3 was by means of not more than two ¾-in. bolts, and that to column C2 was not more substantial. That the end connections of this strut were of little value in indicated by the fact that column C3 bent, with curvature sharply convex toward column C2, at the point at which the I-beam strut had been attached, completely breaking the connections without crippling the strut.

Examination of the wreckage showed that the thickness of the plaster on column C2 was 1 in. greater on the north side at the top than at the bottom on the same side. This indicates that the column must have been out of plumb by about 1 in. at the time of plastering, and the difference was taken up in the plaster. This inclination of that column toward the south at the top, while assisting in a general southerly movement of the roof during its fall, would not be sufficient to start the movement.

The committee concludes that in spite of the defective conditions at the columns there is no evidence that the failure started in that vicinity.

List of Principal Defects—The A. A. E. committee lists the following features of the building as most deserving criticism:

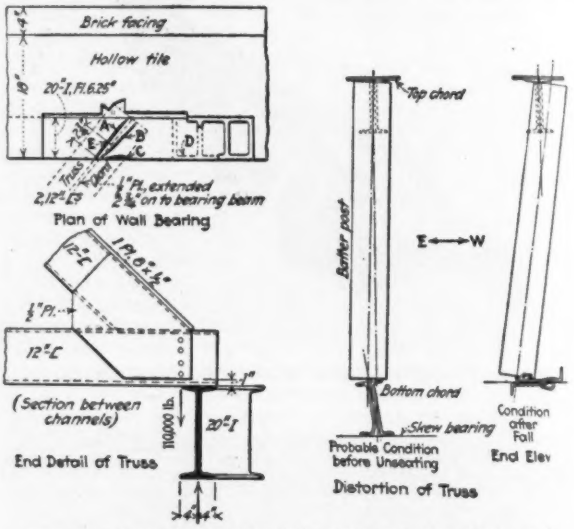


FIG. 7. WALL BEARING AND DISTORTION OF MAIN TRUSS (A. G. C. REPORT)

The weakness of the upper gusset, connecting the batter post to top chord, is strongly emphasized by the contractors' committee.

Support of main truss on a thin wall lacking solidity and mass.

Support of main truss on a skew bearing, combined with lack of stiffness in the gusset between the end post and the lower chord of the truss.

Failure to anchor trusses and heavy beams into walls.

Scant bearing at walls.

Insufficient section area and inadequate details of truss members.

Inadequate column bracing.

Absence of lateral support at intermediate panels of truss T11.

Absence of diagonal bracing between other trusses.

Inadequate strength of roof slab.

Some of these defects are not believed to have been immediately contributory to the event of the collapse, but "it would require the correction of all those listed to convert the building into a safe structure."

All these defects represented direct violations of the District of Columbia building law. Fifteen violations are found by the committee. Besides those indicated in the preceding comments there are such as the following: Concrete reinforcement left to the judgment of the contractor; plans filed with inspector of buildings not adhered to; purlin 41 overstressed 54 per cent, namely to 24,500 lb. per sq.in.; bolts instead of rivets

used for field connections for trusses; and building not fireproof.

The Question of Responsibility; A. G. C. Findings—Discussions of the professional and public responsibility for the conditions disclosed in the Knickerbocker collapse are presented by both reports.

The board of the A. G. C. places responsibility very definitely upon the architect and the steel contractor, but exculpates the building department and the contractor. It presents noteworthy suggestions for improvement of building supervision. Essential extracts are quoted here:

Contractors' Views as to Responsibility

In the erection of a building, particularly a building to be used as a public gathering place, all persons engaged in designing and erecting the structure, like the operators of public utilities, are jointly and severally responsible for its safety. The highest degree of responsibility undoubtedly rests upon the architect, as it is upon him that an owner relies for a properly constructed building; but every other agency involved in the project has an individual responsibility for the character of its work.

Municipal approval and inspection may include, in some instances, investigation into features of design, but to completely check the design of each structure erected would exceed the working capacity of a municipal building department. It would require a staff of experts almost equal to the combined forces of private designers and would entail an expense and duplication of work too great for a municipality to bear. Field inspection also is limited by a like consideration of expense.

In the case of the Knickerbocker, responsibility for the disaster cannot be justly laid to employees in the department of building inspection, except in so far as it may be shown that an official or employee has failed in his duty of apprehending any violation of the building code. But even if this is finally shown to have occurred, it would in no sense relieve the other agencies of construction from their respective responsibilities.

If any parts of the building, built in accordance with plans and specifications as either drawn or accepted by the architect, are found to be inadequate or improper, then he cannot avoid responsibility for the condition of such parts. Neither can he disclaim responsibility for violation of the plans and specifications, if laxity in supervision has made such violation possible; though in the latter case the agent of the violation should be held fully responsible for his own acts. The fabricator, on account of difficulty in securing certain material, submitted an alternate design of his own, and this, it appears, was approved by the building department and accepted by the architect upon their approval. Adoption of this design obviously entailed responsibility to the owner for its safety, but, on the other hand, did not in any sense release the fabricator from responsibility for departures from safe practice.

The steel design of the Knickerbocker contained serious departures from established practice, which are believed to have been a vital factor in the collapse, and while the architect may be culpable for not checking it, the fabricator, in whom he relied, cannot escape his moral responsibility for these departures. In such instances the subcontractor obviously becomes an agent of the architect in supplying a design, as well as an agent of the general contractor in executing the work.

No responsibility appears to rest upon the contractor by reason of the quality of his work or any non-compliance with the plans and specifications; but by conforming to these instruments, as required in his contract, which did not provide for anchoring trusses to the walls, he was made a party to infraction of the building code.

It is the duty of ownership to insist upon adequate inspection and to pay a fee for architectural service sufficient to provide such inspection. If the owner presses his architect to reduce this fee below that commonly recognized as necessary to give adequate inspection he should not expect the building department to relieve him of responsibility for such action. Should the owner induce his architect to reduce the cost of structural design at the risk of endangering its safety, he jointly with the architect should share responsibility for the results.

In the case of the Knickerbocker, the architectural fee, as shown by evidence at the coroner's inquest, was lower than that advised by representative architects, and an examination of the building indicates that while the decorative features were elaborately executed, structural features were inadequately provided for. Whether any action of the owners resulted in this condition has not been determined, but, if so, the ownership should share the responsibility.

A. G. C. Recommendations—Several specific suggestions and recommendations are made by the A. G. C. board for prevention of the conditions responsible for the Knickerbocker disaster. One of these is the suggestion that, as thorough examination of plans and inspection of building work cannot be provided by cities with general funds, building departments might make a charge for each permit depending on the value of the structure, sufficient to pay for checking the design and for inspection. Improvement in building codes is advocated, as "many codes are deficient in vital particulars, to such an extent that an unsafe structure can be built."

Licensing is not believed by the board to be a remedy for bad architectural and engineering practice, but compulsory registration of designers and constructors with local building authorities is recommended.

On the subject of adequate fees and adequate work, the board says:

In the case of the Knickerbocker the plans and specifications were not complete, and testimony before the coroner showed that the inspection was inadequate. In any building there are items of construction unforeseen by the designer which must later be added, but when, on a structure like the Knickerbocker, costing about $77,000, there are more than fifty such items, there would appear to have been incompetence, indifference, or both.

The committee recommends that the fees of architects and engineers be made sufficient to enable them to give competent and complete service. Fees recommended by the American Institute of Architects nad the American Institute of Consulting Engineers are reasonable and proper and have had recognition by the courts.

What Engineers' Committee Recommends

Conclusions of A. A. E. Committee—Diverging from the views just quoted, the committee of the American Association of Engineers does place a measure of responsibility on the contractor. It further demands critical checking, by a duly qualified structural engineer, of all structural features of public buildings, and suggests that thorough inspection of plans and rigid field inspection by the public building officials are in the interest of conscientious builders. It makes no reference to licensing or registration. The conclusions are as follows:

In the opinion of the committee this disaster was the result of bad practice on the part of the architect and the contractor.

The testimony offered at the coroner's inquest showed that the architect allowed the contractor to change the design of the roof framing and that he did not check the sufficiency of the new design but instead relied on the check of the computer in the office of the building inspector. No check on the subcontractor's draftsman was required for details of construction.

The contractor because of the substitution of a new design was placed in the position of being directly re-

sponsible for the design, but that did not relieve the architect of his responsibility to the owner.

From the number of violations of the building code it is evident that the designing was carelessly done or else, what is worse, the violations were deliberate.

To have the inspector of buildings assume the responsibility for the sufficiency of the details of the design of buildings would be beyond the intent of the law. It would virtually put the work of designing buildings in the hands of the inspector and relieve the architect from that function almost altogether.

Critical checking by a duly qualified structural engineer should be required for the structural details involved in the construction of every public building of importance, and drawings bearing the signature of the engineer as a guarantee of the adequacy of the design and details should be filed with the inspector of buildings.

When an architect accepts a fee for plans, specifications, and superintendence, the owner has a right to expect a building conforming to all the building regulations and the function of an inspection department should not be to relieve the architect from the responsibilities which are his.

At the same time the best interests of conscientious contractors, engineers, architects, and owners, as well as those of the public, would be served by an exacting and thorough examination of general plans by municipal officials, followed by rigid field inspection.

Since this catastrophe, there has been much agitation advocating a new set of building laws, but it is here emphasized that such laws will not insure against failures of this kind if their enforcement is not insured. Valuable as a simplification of the code would be, the first need is for the enforcement of the law.

Exposure Fire Hazards and Protection in the Burlington Building Fire

(Extracts from a preliminary report issued by the Chicago Board of Fire Underwriters)

IMPORTANT teachings concerning exposure-fire hazards and means of protection are brought out in a preliminary report on the Burlington Building fire of March 15, prepared by W. D. Matthews, chief engineer of the Chicago Board of Fire Underwriters. The report covers the major phases of the fire (see *Engineering News-Record*, March 23, p. 495), but states that other phases are still under investigation.

Reviewing the origin of the fire, the report describes its rapid spread through the block of printing-house and factory buildings between Canal and Clinton Sts., Van Buren to Jackson, in one of which it started. Delay in either discovery of the fire or response to the alarm was a factor in the early stages. Then the fire spread from building to building through unprotected (and some wire-glass-protected) windows. Thus, as to the fully-sprinklered Atlantic Building, which was in the block destroyed, the report refers to the entry of fire through wire-glass windows thus:

The condition of greatest exposure to the Atlantic Building was an 8-story building 138 ft. long, 102 ft. high, burning fiercely and shooting flames and heat into a court only 5 ft. wide against wired glass. Here was a building protected against the worst exposure by wired glass, but with a condition existing which wired glass is not expected successfully to resist. In the case of the Burlington Building, the exposed window openings (east wall) were glazed with ordinary glass in woden frames, except that the fire-escape windows were wired glass. Distance (80 ft.) alone was all the protection this building possessed, and distance was insufficient with the very high temperatures prevailing.

The spread of the fire to the Burlington Building occurred very soon after the beginning. The alarm was given at 12.50 a.m., the first engine company arrived at 12.52. Soon afterward nearly the whole printing-house block was on fire, and by 1.20 the Atlantic Building and the Burlington Building were on fire.

The Burlington Building had no automatic interior protection. It had a fair supply of hand fire extinguishers; also two 4-in. standpipes with 100-ft. lengths of 1½-in. linen hose and 2½-in. outlets each floor supplied by three 800-gallon steam pumps, two of which were automatic. Employees used the small hose and the fire department used the large hose as well as leads that were brought up the front stairway and the fire escape. The fire was fought by the department working upward from the 9th floor.

This building is not by any means so badly damaged as some reports have stated. Present indications are that the structural steel is intact and that few of the floor arches will need to be replaced. Much of the terra-cotta trim on the exterior walls is damaged. A very large percentage of the wired-glass windows on the south, west, and court walls was destroyed. Beginning at the 9th floor and going upward, it appears that the loss is total on wooden top flooring and its nailing strips, all wooden trim and combustible contents, plastering, marble and tile dividing partitions. The tile partitions (with metal and wired-glass doors) enclosing stair and elevator openings are damaged to some extent, but apparently most severely in the warping of metal and fusing of glass, although instances were noted where the tile was bulged and spalled. The tiles protecting the interior columns were calcined and spalled in many cases and will have to be replaced, but in no case was the steelwork exposed by action of the fire. Needless to say, records and papers exposed in the open or filed in steel sectional cabinets were destroyed. Records in the vaults are reported to be intact.

The Burlington Building was much more worthy of the descriptive misnomer "fireproof" than many buildings advertised as such. It was, comparatively speaking, a well constructed building and it had what many office buildings in this, as well as other cities have not, viz., enclosures around all floor openings sufficiently substantial probably to have stopped a fire originating on any one floor, from spreading to another floor. Taking it as it was and giving it credit for all of its good points, the fact remains that it was a poor excuse for housing records that will cost millions to replcae.

Are there many people who fancy that their goods are immune from fire because contained in one of these buildings? If there are any such, here is a very good example of how a good building not only did not protect its contents, but contributed to a considerable extent in its destruction.

The lessons to be derived from the Burlington Building fire are:

(a) Protect exterior openings against *all* exposures. Wired glass in the east wall, while it might not have prevented a loss in this building, would at least have stood up much longer than ordinary glass, kept out sparks for a long time, and given the fire department a much better fighting chance.

(b) Omit in the construction all materials of a combustible nature, that is to say, wooden top floors and nailing strips, wooden doors, trim, sash, etc., etc.

(c) Subdivide floor areas as much as possible by substantial partitions anchored to floor and ceiling.

(d) Make each floor a separate fire area by enclosing floor openings (stairs, elevators, etc.) with standard materials.

(e) Omit easily damaged and expensive building decoration, such as marble.

(f) Eliminate combustible furniture and fixtures.

(g) Use metal filing cabinets in place of wooden ones to reduce the amount of combustible material, but do not expect these metal cabinets to protect papers if surrounded by burning material generating temperatures sufficiently high to fuse brass and glass, as was the case in this building.

(h) Install automatic sprinklers, with the knowledge that they are the most efficient fire extinguishers known but have limitation, as was demonstrated in the Atlantic Building.

(i) Locate standpipes inside stair towers so that firemen may fight fires on floors using the towers as shields.

Curved Pile and Rock Breakwater Built in Deep Water

Piledriver Follows Radius Cable or 50-ft. Chord With Offset Sights—Transits on Pile Platforms Check Lines

BUILDING a pile breakwater on curves of varying radii in water 15 ft. deep, at Chicago, required special survey methods to insure accurate line and location, since this structure is to form eventually the west side of the formal or decorative part of a lagoon in the new Lake Front park, as described in *Engineering News-Record*, Oct. 13, 1921, p. 614. All the work was done in the open water of Lake Michigan, and the piledrivers were kept on the outer or lake side of the breakwater. A plan of the work is shown in Fig. 1.

For radii up to 500 ft. the center of the curve was located by triangulation and marked by a pilot pile, in the head of which a vertical bolt was driven. A ring on the end of a ¼-in. wire cable was placed over the bolt, the cable being coiled on the piledriver and having a tag

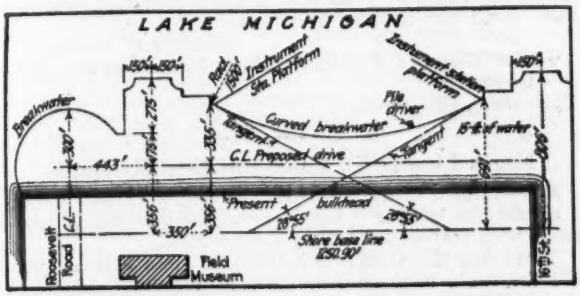


FIG. 1. BREAKWATER BUILT ON CURVED LINES IN DEEP WATER

tied to it to mark the required radius distance. As each pile was placed, the driver was shifted to bring this tag into the leads. The inner row of piles was driven first, and the driver then moved out to place the outer row, the distance being measured by a tape from the piles already driven. At some of the corners it was necessary to mount a piledriver on the two lines of piling in order to place the cross bulkheads.

A chord and offset method, using 50-ft. chords, was used for locating the breakwater line on a curve of 1,500 ft. radius extending over a length of 1,250 ft. At each end of the curve location was placed an instrument platform 8 ft. square, supported on four piles, the instruments sighting on a base line established along the shore. In starting, the instrument was sighted on the base line station and a guide pile was set at 50 ft. from the instrument. The piledriver then worked along this 50-ft. chord. On the last pile a horizontal plank was bolted, with a pole and flag upon it at the required offset distance, 1.66 ft. This is shown in Fig. 2.

At the end of the first chord, the observer on the piledriver sighted from the leads on a backsight placed at this same distance on the instrument platform. The driver then worked ahead another 50 ft., the observer sighting from the leads and along the completed part of the chord to the backsight. At the end of this distance, the observer sighted upon the backsight flag of the first chord. The movement was checked at intervals by the instrument man on the platform, but much of the work was located simply by the backsights.

In this way the curve was laid out as a succession of 50-ft. chords. Since the bow of the piledriver was lashed snugly against the piles already driven there was little difficulty in keeping line, but any slight irregularities were adjusted when the waling timbers were bolted up. In addition to being lashed to the piles, the driver was moored by lines leading from one side of the stern to the completed work and from the other side of the stern to an anchor. With these lines and a bow line the driver was readily shifted and held in position.

The inner row of piles was first driven for the entire length of the curve and then the driver placed the outer row and the cross bulkheads. This part of the work required much more shifting of the piledriver, as it had not only to traverse the curve but to move in and out at each cross bulkhead.

For curves up to 100-ft. radius the 12 x 12-in. wales were built up of two pieces 6 x 12-in., four 3 x 12-in. or six 2 x 12-in., to permit of bending to the curve. The 6-in. steel channel for the outside top wale was sufficiently flexible to bend in place, the sharpest curves being of 75-ft. radius. Carpenter gangs on scows placed the waling timbers on the two lines of piling and the cross bulkheads.

Rock for the filling was dumped outside the breakwater by scows, and was put in place by dipper dredges. Although this method involved additional handling of the material, it was more rapid and economical than placing the stone direct from the scows to the breakwater by means of a crane and grab bucket. This latter method would have detained the scows materially and would probably have resulted in more or less damage to the scows.

Construction was relatively slow owing to the curves and the irregularity of line of the breakwater, but 7,500 ft. of completed work was built in 5½ months. This included the two rows of piles, sheeting and stone fill. Unusually frequent fluctuations in the lake level occurred throughout the summer, the extreme range being 3 ft. This caused some trouble in keeping the pile heads at uniform level, as measurement from the water surface was not reliable. A 150-ft. opening was left near the middle of the breakwater for the passage of scows and floating equipment. With the fluctuations in lake level there was an almost continual change of current through this opening, connecting the lake with the large enclosed water area. This current, flowing sometimes inward and sometimes outward, was a source of trouble in handling scows through the opening and caused variable currents within the enclosed space.

This breakwater was built for the South Park Com-

FIG. 2. CHORD-OFFSET METHOD OF GUIDING PILE DRIVER

missioners under the direction of Linn White, chief engineer, with M. N. Lovewell and John P. Ball, as assistant engineers. The Great Lakes Dredge & Dock Co. was the contractor, the work being in charge of John F. Cushing, vice-president and Wm. Murphy, general superintendent.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Anthology of Scientific Verse

Sir—I am making a collection of verse whose subject matter relates to the sciences or the various branches of engineering, with the intention of publishing an anthology of such verse. It has occurred to me that among the readers of the *Engineering News-Record* there must be some who have in their possession verse of this nature. I should be pleased to receive such verses, together with the names of their authors. (My address is—Dr. C. E. Ruby, Box 130, M.I.T., Cambridge, Mass.) Details as to place of publication, if the verses have been published, will be appreciated.

Cambridge, Mass., Feb. 23.

C. E. RUBY,
Massachusetts Institute of Technology.

Teaching Descriptive Geometry

Sir—For a number of years I have taught descriptive geometry from several different textbooks. New textbooks are coming onto the market continually. To my mind there is such a display of ignorance on the part of the writers of these textbooks that I am constrained to offer a few comments with the idea of helping some of your readers, especially those who teach the subject.

For example, I have just read a circular of a new text on this subject in which first-angle projection is taught. In another new text just received the ground line, traces of planes on the planes of projection and the like are used. To my mind that sort of teaching is decidedly out of date. What draftsman out in practical work in an office ever uses the trace of a plane or a ground line such as these textbooks use? They do not use them. The draftsman uses the object itself. He starts with its center line or some line or point on the object. True, he may cut a section and show where the cutting plane lies and the direction of the line of sight, but he does not carry the trace of the plane to the ground line and all that sort of nonsense.

There is just one textbook that presents this subject in conformity with the way it is used in practical work, and that is the one written by Millar, Maclin and Markwardt of the University of Wisconsin. The book is published by Tracy & Kilgore, Madison, Wis. I am not interested in promoting this particular book, but it is the only one I know of that presents the work in a logical practical fashion.

Soon after I was graduated from the University of Illinois I started to work as a templet maker in a large shop in Chicago. One of the first experiences I had was to make a lot of right-hand pieces for left-hand pieces and vice versa. I received a "calling down" that made a lasting impression on me. I had been taught wrong in school. Why cannot our teachers and writers of textbooks wake up and get a little nearer the standard shop methods.

When the subject is properly taught, the student not only gets into the right habit of thinking of projection, but he also grasps the subject much more easily. If you wish to talk of a plane or represent a plane use a point and a line to define the plane, or two intersecting lines or two parallel lines, just as you do when you are actually drawing a bridge-abutment wing-wall. Why worry about the trace of the plane upon some other plane that is somewhere in space? Further illustrations might be given.

Since using this method we have had no trouble in keeping up interest in the subject and we get results. Any textbooks we receive that present this matter in the old fashioned way will immediately go to the scrap heap.

B. KETCHUM,
Professor of Civil Engineering,
Salt Lake City, Utah, Dec. 8, 1921. University of Utah.

Past Warnings and the Future

Sir—I think many readers of *Engineering News-Record* will have enjoyed that well written and excellently illustrated article, "Controlling a Mountain Torrent in Switzerland," which appeared in the issue of March 2.

We may look back now, not without profit, and see how eloquently, but how fruitlessly, John Ruskin went forth to battle for those rich slopes of Italy, Switzerland and Germany, to save them from their fierce, ungoverned streams. He shows us how, even in 1871, the principles of control of mountain torrents at their sources, and of terraced irrigation, as practiced by half savage peoples in China and Borneo, and then in Italy by that great engineer Leonardo da Vinci as early as 1500 A. D., had been so little used—but wherever used, how powerfully successful. (See "Arrows of the Chase," Letters on "Roman Inundations," and "Verona and Its Rivers" by John Ruskin.) Not without profit, I say, for by examination of repeated disasters of the past, we may win our way to greater public safety for the future.

Have we not had tragic lessons from our grade crossings? I believe (I have no figures) the toll of victims in the United States, every week exceeds that arising from the Knickerbocker Theater disaster. Is our concern what it should be? And does it beget the merited action? We blame our fathers for their slowness in learning such lessons: shall our children still blame us?

HADDON C. ADAMS,
Junior Highway Engineer, Illinois State Highway Commission.
Springfield, Ill., March 7.

Urges License To Raise Building Standards

Sir—Apropos of the recent Knickerbocker Theater failure I should like to offer a few ideas on the licensing of engineers with respect to building construction.

Years ago the architects insisted on state licenses; why did they as a body advocate them? Privately, to protect their pocketbooks, and openly, to protect the public. One of the practices then in vogue among ambitious carpenters and contractors was to offer to make the necessary drawings, secure a permit and put up a building without charge for the drawings. Owners considered the saving in architect's fees and accepted such propositions.

Now this practice affected the earnings of architects, but did they say that when they agitated for building codes that would read "permits will be issued only on drawings and specifications properly made and submitted by a competent architect?" That is the way I think they had it at first. The word "architect" really meant nothing, as any one who could make any kind of a drawing could claim to be an architect. Judgment as to competency was up to the local building department, and the "hail-fellow-well-met" ways of the contractor went further than the dignity of the architect. A more effective cure was then sought in the state license laws. In some cases the contractors took out architects' licenses, as they were entitled to do; for in most cases the law provided that any one then practicing the profession or who had made the plans for two or more buildings could take out a license during a certain period of grace. After that period an examination became necessary, and the building codes were changed to read a "licensed architect" instead of a "competent architect."

So much for the architects' license law. It was the doctors, however, who started the ball rolling. To practice medicine at one time it was necessary only to have a diploma from some so-called medical school or to have studied a certain number of years under another physician; in plain words, to have served an apprenticeship. At a number of so-called medical schools diplomas could be secured in short order on payment of the price, and in the eyes of the law the holders of such diplomas were physicians. Then *legitimate* physicians got together and arranged matters so that no one was allowed to practice medicine unless he had passed an examination by a state

board of medical examiners. The fact that he had graduated from a medical school did not count. That stopped the practice of the medical profession by any except those properly and legally qualified. Public confidence was again restored and the proper respect and standing of the medical fraternity was assured forever.

In those times a couple of law books and an office constituted a lawyer. But the lawyers got together and passed laws calling for examinations at the bar before one could legally practice; and again the public was saved from being imposed upon by shysters, as the incompetent could not practice law. No one can deny that the licensing of these three professions was a benefit to the public and also to the professions themselves.

The doctors, with their national medical society and state associations, have made and enforced a code of ethics that, morally if not legally, makes them a combination in restraint of trade. Likewise, the American Institute of Architects has its ethics, but the proportion of architects who are members of the A. I. A. is not so large as that of the physicians, who belong to medical societies. The lawyers have their ethics and their state and bar associations, but do not fix a certain minimum emolument for their services as do the architects and physicians. You can dicker with a lawyer.

Now the engineering profession is not so old as any of the others either in knowledge or in the eyes of the public. As a matter of fact, until iron and steel were applied to buildings the engineer was not a necessity in the building field and when he did become necessary, the architects were already thoroughly entrenched with their state license laws and building code requirements. They saw to it that the necessity for an engineer did not become a matter of public knowledge; and they have been opposed to licensing engineers and changing building codes for fear the engineer would do the work of the architect.

Times have changed, and today the engineer should be protected as well as any other professional man. Engineering details of construction determine the safety of a modern office, theater or industrial building, and the competence of the engineer should be established just as surely as the competence of a physician to practice his profession.

The architecture on a building today is merely the ornamentation; yet, due to archaic laws, the architect is recognized as the supreme authority on a subject he knows nothing about. Today architects are allowed to make drawings, taking their sections from a Carnegie or other handbook, file them and get a permit. If they do hire an engineer to do the engineering, the engineer cannot compel the architect to do a single thing in the way of changing his plans and, as in the case of the Knickerbocker Theater, the architect can allow the plans of the engineer to be changed without consulting him.

This raises the question, should a fabricating company be allowed to make drawings for the architect or to substitute plans for his? I say no, because those employed in such companies have, as a rule, very rarely had the experience that qualifies them to design properly. Experience is what counts in engineering more than in any other profession, and judging from the design of the Knickerbocker Theater and the details of fabrication of the steel, not only inexperience but also absolute incompetency was shown. The mere fact that a man has graduated from a technical school does not make him a competent designer. He may have all the theory but he has no knowledge of application or of details, etc. After graduation a man should spend at least four years detailing, in the field and in the shop, to become an absolutely competent designer. In addition to all this, all plans should be thoroughly checked before being submitted, and the checker should be an engineer other than the designer. Building codes should call for this.

If we have no license laws and the engineering profession consequently has no legal standing, how can we insist on safeguards as to engineering design and construction so long as the architect is licensed and building codes recognize his decision as final? This is a condition for which the engineering profession as a whole is responsible. So long as we see the cause and do not try to correct it, accidents like the Knickerbocker failure are our fault and will continue to be our fault.

F. F. CARMIENCKE,
Structural Engineer, Willys-Overland Co.

Toledo, Ohio, March 3.

In Support of Corps of Engineers

Sir—I was not a little surprised to read a letter "In Support of Corps of Engineers" (your issue, Dec. 1, 1921, p. 909), and to find that it should appear necessary to direct or call attention in the United States to the efficiency of the Corps of Engineers. No branch of your service gained higher distinction in France. It was the one branch that won immediate praise even from those inclined to be most critical of their allies.

Your correspondent cites the corps' achievements in France, which were on a scale of operation that called more particularly for powers of organization than for individual or sectional initiative. Less is known, naturally enough, of the corps' representation in the North Russian "sideshow." I had the privilege of being closely associated with the 1st Battalion, 310th U. S. Engineers, commanded by Lieut.-Col. P. S. Morris, throughout their service with the Allied Forces at Archangel, and of seeing their work in detail from base to front line. Arriving at Archangel in September, 1918, fresh from camps, the battalion's ardor for the fray calls for little praise. Any good troops would have shown the same spirit—some troops did not. But their ardor was speedily converted into effective and gallant service, which was proved repeatedly in a diversity of ways during a severe North Russian winter. There was no question as to the effectiveness of the corps' training or as to the rapid and remarkable adaptability of the battalion to abnormal conditions. Whether in the construction of winter barrack-huts, the wiring of front-line entanglements or the building of block-houses and emplacements, whether on river, railroad or forest track, the 310th made good. They gained the lasting esteem of Major-Gen. Sir Edmund Ironside, commanding the North Russian Expeditionary Forces and of their British comrades of every rank and unit.

RALPH S. G. STOKES,
Formerly Colonel, Royal Engineers.

Kimberley, South Africa, Feb. 8.

Rain Gage and Intensity of Rainfall

Sir—About six years ago the writer devised and installed a simple recording rain gage which has given such satisfaction for the outlay that he is prompted to pass a description on to others who are interested in collecting rainfall intensity data.

A standard 12-in. recording gage, making one revolution every 12 hours, built for heads of 75 in., is used. The gage is connected to the base of a 4-in. standpipe about 7 ft. long, which receives the water, through a short piece of ¾-in. pipe, from the collecting funnel above the roof. The top section of the collector, a cylinder, has a section just ten times that of the standpipe so that a 1-in. rain will show 10 in. on the chart.

The accuracy of the instrument has been tested by pouring water into the collector at variously measured rates and by means of a standard rain gage on the ground and is believed to be sufficiently accurate for general purposes.

The records show that we may expect the following for this place: 0.8 in. in 8 min.; 1 in. in 13 min.; 2 in. in 1 hr.; 3 in. in 3 hr.; 4 in. in 12 hr.; 5 in. in 24 hr. These rates have all been reached or closely approached several times during the six years, but have been exceeded by only one rain (6.4 in. in 18 hr.) which, however, showed no intensities for shorter periods exceeding those given above.

J. H. DORROH,
Dean, School of Engineering,
University of Mississippi.

University, Miss., March 8.

NEWS OF THE WEEK

New York, March 30, 1922

Baltimore Plans $50,000,000 Harbor Project

Tentative Layout and Policy Look to Systematic Development of Port Under Central Control

Comprehensive plans for the improvement of Baltimore harbor involving projects that will cost $50,000,000 and will require at least twenty-five years to complete have been announced by the Baltimore Port Development Commission.

The principal elements of the plans are: (1) McComas St. terminal, to be built on the Locust Point water front with a frontage of about 4,800 ft. between Port Covington and Fort McHenry, which will provide eight piers each 1,200 ft. long and 250 ft. wide with berths for thirty-three 12,000-ton steamers, together with twenty warehouses and capacity for 2,500 freight cars; (2) reclamation of the Patapsco flats and the construction there of five piers, each 1,200 ft. long and 300 ft. wide with berths for twenty-three 12,000-ton steamers, together with twenty warehouses and capacity for 4,900 freight cars.

Provision has been made also for the construction by the commission or by the railroads of eight piers on the property of the Canton company near Riverview, and an equal number at nearby Pennsylvania R.R. terminals. Other items include the improvement of existing municipal piers and of the city's Hughes St. property, and several minor projects on the eastern side of the harbor.

Leases to Precede Construction

The announced policy of the commission contemplates the ultimate unification of control and operation for all terminals and their connections with the trunk-line railroads serving the port. Improvement will be undertaken, therefore, with a view primarily to the needs of the port as a whole and secondarily to meeting the immediate requirements of lessees. The commission will design and construct improvements for lessees or will construct to the lesseess' plans provided the latter are approved by the commission. The commission will consider also application from lessees for the improvement of habor facilities anywhere in the port provided these are in line with the policy of the commission.

Construction of any improvement will not be undertaken until the city has taken title to the property involved and until after the execution of a ten-year lease at an annual rental equal at least to the sum of the annual interest on the cost of acquisition and improvement of the property and the annual sinking or retiring fund. In the case of improvements on city-owned property the appraised value of such property ls to be included as part of the cost of improvement.

The commission records its judgment in favor of the construction by the railroads of a belt line around the city that would tap all the railroads entering Baltimore outside the congested area. Such a line, it points out, would make possible ready interchange of freight between the various elements of the port development.

"The Public Improvement Commission," says the Port Development Commission, "now has available for immediate use in the development of the harbor a fund af $2,200,000. With the co-operation of the Improvement Commission, the Port Commission will have at its command the use of this sum. Ten million dollars of the $50,000,000 development loan already has been authorized and will be available as soon as leases are made; and when made, a part of this loan can be used for replacing the amounts advanced by the Public Improvement Commission. In this way a revolving fund will be kept intact for a working capital and the Port Commission would be enabled to initiate immediately the improvements in accordance with the plans herein set forth."

Flat-Slab Case Before Federal Court of Claims

Suit against the U. S. Government for infringement of concrete flat-slab patents has been brought by C. A. P. Turner of Minneapolis, one of the earliest patentees in the flat-slab field. This action of Mr. Turner is a different legal process than has hitherto been applied to the flat-slab situation. All previous flat-slab cases have been in the federal courts and were suits against infringement of patents by one or the other of the patentees.

This case is a suit in the Court of Claims, the only court in which action can be taken against the federal government, and is expected to develop from the beginning the facts and representations in the flat-slab controversy, which have been left in some confusion by different district courts and Courts of Appeal decisions in the earlier patent suits.

New Jersey Engineer Registration Board Appointed

Under an act passed last year by the New Jersey Legislature, Gov. Edwards on March 17 appointed the following as comprising the board of professional engineers and land surveyors:

Thomas J. Wasser, state highway engineer, for the one-year term; George H. Noble, of Clifton, for the two-year term; John C. Remington, Jr., Haddonfield, for the three-year term; Harvey Snook, county engineer of Sussex County, for the four-year term; and Hugh A. Kelly, engineer for the department of Parks and Public Property, Jersey City, for the five-year term.

Under the act the term of office is five years but the appointments are made as indicated above so that a new member may be appointed yearly.

Philadelphia Engineers Hold Hydro-Electric Symposium

Engineers of Philadelphia, under the auspices of the Engineers' Club, held another hydro-electric conference March 21 similar to the successful one held last year. This symposium was under the auspices of the local sections of the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and in co-operation with the power division of the American Society of Mechanical Engineers. A remarkably good attendance was had at both sessions, afternoon and evening, and at the dinner. The conference was started at a luncheon at the Engineers' Club, at the end of which Dr. Arthur M. Greene, Jr., the dean-elect of engineering at Princeton University, gave a short talk on the modern trend in engineering education. Dr. Greene presided at the technical sessions devoted to the hydro-electric program.

Chief attention during the meeting was given to the Queenston-Chippawa development of the Ontario Hydro-Electric Power Commission, but there were additional papers by N. C. Grover, chief hydraulic engineer of the U. S. Geological Survey, on the relations of water resources to the country's development; Prof. Charles M. Allen of Worcester Polytechnic Institute on the salt velocity method of measuring water in pipe lines; R. D. Johnson on studies in the problem of unsteady flow in open channels, and by H. Birchard Taylor and Lewis F. Moody of the Cramp Co. on the hydraulic turbine in evolution. Besides these papers, the Queenston-Chippawa job was described by H. G. Acres, T. H. Hogg, E. T. J. Brandon, and P. B. Yates. Finally, F. H. Rogers of the Cramp Co. gave a detailed lecture on the 55,000-hp. turbines in the new Canadian-Niagara project.

Chicago Union Station Program

Great progress is to be made in 1922 on the new Union Station in Chicago. Much of this will be evident to the public, supplementing the foundations, sewer and street alterations, viaducts, and other inconspicuous auxiliary work which has been in progress for some years. It is expected to erect all the steelwork for eight stories of the 21-story headhouse and office building and for the concourse and to lay some of the new station tracks.

As a preliminary to this work, suburban traffic at the south end of the station will be transferred in April to a temporary station, one block south, using part of the permanent tracks which have been laid at the new grade, about 4 ft. below the present track level. A contract for 18,000 tons of steel for the headhouse, concourse and approach viaduct was placed in February. All this work is under the direction of J. D'Esposito, chief engineer of the Chicago Union Station Co., and A. J. Hammond, assistant chief engineer.

Make Progress Toward Uniform Road-Material Specifications

Testing engineers representing the state highway departments of New Jersey, Delaware, Maryland, Virginia, West Virginia, Pennsylvania, and Ohio, met with officials of the U. S. Bureau of Public Roads in Washington, March 23. The object of the meeting, as explained in last week's issue, was to harmonize the specifications for materials used in road construction and thus enable the use of materials from the same source without difficulty. The committee made rapid progress with the work and decided on uniform specifications as to the sizes and quality of crushed stone, crushed slag and gravel for use in the following types of paving: Concrete, bituminous concrete, sheet asphalt, brick, bituminous macadam and waterbound macadam.

Specifications were also decided on for tar and asphalt for bituminous roads and for the quality and grading of sand for concrete and bituminous concrete construction.

The work of the committee along with that of committees representing other groups of states will be reported at the next annual meeting of the American Association of State Highway Officials for final adoption, probably in December.

A meeting of a committe of the American Society for Testing Materials for the purpose of revising its specifications for highway materials was held at the Bureau on March 24.

A sub-committee on non-bituminous materials of the committee on road materials discussed specifications and standard tests for road materials. The membership of this committee is composed of engineers and producers. Among the propositions discussed were specifications for the slump test, specifications for the use of calcium chloride as a dust preventative on gravel roads, and methods of testing subgrades. Another sub-committee discussed specifications of oils, asphalt and tar.

Boise Granted Preliminary Power Permit

The City of Boise, Idaho, has been granted a preliminary permit for a power project on the North and South Forks of Payette River, Idaho. The proposed scheme contemplates a complete hydro-electric development of 8,000 hp. capacity on the North Fork of the river to be followed by development of 4,000 hp. on the South Fork as soon as market conditions warrant. The project on the North Fork includes a diversion dam 75 ft. high, which will create a storage of 2,300 acre-ft. A 7-ft. pipe line is to extend downstream from the dam for one-half mile and connects with a tunnel 1,000 ft. in length, which will be driven through the mountain dividing the North and South Forks of the river. The power house will be located on the South Fork. The turbines will operate under a head of 250 ft.

The proposed development on the South Fork of the river includes a diversion dam 50 ft. high which provides 1,200 acre-ft. of storage. An 8-ft. pipe line will lead from the dam 4,000 ft. downstream to the power house where 4,000 hp. can be developed under a head of 97 ft.

Bayonne Gets Rights to 50 M.G.D. from Ramapo River

Right to divert 50 m.g.d. from the Ramapo River for water supply was granted to Bayonne, N. J., by the Department of Conservation and Development on March 23. Shortly before, the department denied an application from Bloomfield for 10 m.g.d. The Bayonne permit contains provisos stated in the editorial columns of this issue. Clyde Potts, consulting engineer, New York City, is engineer for Bayonne.

Tennessee Engineers Must Register by April 9

H. C. Hibbs, secretary of the State Board of Architectural and Engineering Examiners of Tennessee, has issued a statement in which he calls attention to the fact that architects and engineers practising within the state must be registered by April 9, 1922, or become violators of a chapter of the registration bill which imposes a fine for non-registration.

Bates Road Tests Started

Motor-trucks started traveling over the Bates test road near Springfield, Ill., this week. The loads on the trucks will be progressively increased until the 63 different pavement sections have been destroyed. The construction of this road was described in "Engineering News-Record" Aug. 18, 1921, p. 274.

Philadelphia Sesqui-Centennial Fair Site Chosen

The directors of the Sesqui-Centennial Association have approved the Fairmount Park-Parkway site for the exposition which is proposed to be held in Philadelphia in 1926. This is the site recommended by a joint committee representing the Engineers' Club of Philadelphia, the Philadelphia Chapter of the American Institute of Architects, and the Philadelphia Real Estate Board. The site embraces land on both sides of the Schuylkill River in Fairmount Park, with entrances from the Parkway at some point west of Logan Square.

The Pennsylvania Legislature in 1921 authorized the Governor of the State to appoint a Sesqui-Centennial Exhibition Commission and appropriated $10,000 to defray its expenses. In the spring of 1921 the Mayor of Philadelphia appointed a committee of 100 citizens to take up the project. This committee, in conjunction with the Mayor of Philadelphia, selected a commission of 25 who were later incorporated as the Sesqui-Centennial Exhibition Association with authority to construct and operate the exposition.

On Feb. 1 of this year the city of Philadelphia pledged itself to appropriate $5,000,000 and as much more as may be required of the funds for the exhibition which is to commemorate the 150th anniversary of the signing of the Declaration of Independence. It is expected that now the site has been selected the commission will solicit an appropriation from Congress. On March 24, President Harding commended the project to Congress.

Marine Borers Subject of Engineering Discussion

An outline of the investigations to be carried on in New York harbor by the committee on marine-piling investigations of the National Research Council was indicated at a meeting held last week at the Engineering Societies' Building under the auspices of the Municipal Engineers of the City of New York. The committee has but recently organized and is now formulating a program which will combine biological, chemical and engineering phases in its investigation.

Various speakers, including R. T. Betts of the Research Council committee; Col. Wm. G. Atwood, director of the investigation, Prof. Thurlow C. Nelson, of Rutgers College, and C. M. Taylor, superintendent of the Port Reading creosoting plant of the Central Railroad of New Jersey and the Philadelphia & Reading R.R., described the life and activities of marine borers and set forth the possibilities for excessive damage in New York harbor that existed in the discovery last year in Barnegat Bay, N. J., of the *teredo navalis*.

From the speeches and ensuing discussion, it was brought out that an adequate investigation should comprise, in its biological phase, studies of food conditions in the water, identification of borers found, their distribution, etc.; from the chemical side, studies upon the salinity of the water, water temperatures, sewage content, and other pollution; and from the engineering standpoint, means of circumventing, if possible, damage from the marine borers. Matters have been complicated, it was pointed out, by the fact that the teredo could live in highly-polluted water, a theory until recently held inaccurate.

Though it was admitted damage might result from the presence of the teredo in Barnegat Bay, the deputy commissioner of the Department of Docks of New York City reported that periodic investigations had failed to reveal either limnoria or teredo in the North and East Rivers, though limnoria had caused some destruction in Jamaica Bay. He asserted that in a recent pulling of several piles in the bulkhead on pier 1 of the Chelsea piers in the North River, piles were found almost as good as the day they were placed and it is persumed that they were driven in 1857.

Passaic Valley Sewer Bids Are Invited

Resumption of construction on the Passaic Valley sewer in New Jersey is indicated in an announcement that the Passaic Valley Sewerage Commission, of Newark, N. J., will receive bids April 18 for the continuation and completion of section 2, comprising the outfall pressure tunnel under New York Bay and Jersey City.

Purchasing Department Created

A bill, passed by the New York Legislature and creating a State Department of Purchase to buy all supplies for state departments and institutions, was signed by Governor Miller on March 15. The Governor is authorized to appoint a superintendent of the department at a salary of $10,000 a year.

Eliminate More Paving Brick Varieties

Recognized Types and Sizes Reduced to Seven at Recent Washington Conference

The standing committee on Simplification of Varieties of Paving Brick met in Washington March 27 under mandate of the conference of Nov. 15, 1921, to consider further eliminations of size and varieties of paving brick. As a result of the deliberations 4 additional sizes or varieties were eliminated, thus reducing the recognized types and sizes to 7. The November conference had reduced the current 66 varieties to 11.

Since this was its first meeting the standing committee effected its organization by electing E. J. Mehren, editor of *Engineering News-Record*, chairman, and H. R. Colwell, of the Department of Commerce, secretary. Organizations were represented as follows:

W. A. Hull, Bureau of Standards; Will P. Blair, American Society for Testing Materials; Col. R. Keith Compton, Federated American Engineering Societies; M. B. Greenough, National Paving Brick Manufacturers Association; L. C. Herrick, American Association of State Highway Officials; E. W. McCullough, U. S. Chamber of Commerce; V. M. Peirce, U. S. Bureau of Public Roads; and W. A. Durgin, chief, division of simplified practice, Department of Commerce.

In the absence of G. F. Fiske, Col. Compton also represented the American Society for Municipal Improvements. The other absent members of the committee were Wm. D. Uhler, American Society of Civil Engineers, and Ross C. Purdy, American Ceramics Society.

Many Organizations Approve

Mr. Durgin reported that the following organizations had approved the eliminations made by the November conference: National Paving Brick Manufacturers Association; American Association of State Highway Officials; American Institute of Architects; American Ceramics Society; Engineers Club of Columbus; Indiana Engineering Society; Western Society of Engineers; American Society of Civil Engineers; the Departments of Agriculture, Commerce, Interior, Navy and War.

The representatives of societies present reported that the reactions they had heard were entirely favorable.

In preparation for the meeting the Manufacturers Association had made a canvass of shipments for the year 1921, and had also canvassed the opinions of the manufacturers with regard to their preferences for the 11 recognized types and sizes. As a result of considering these additional data, together with the facts presented in the survey reported in November, the committee by unanimous vote eliminated the following types and sizes:

Vertical Fiber Lug	3 x 4 x 8½-in.
Vertical Fiber Lug	3½ x 4 x 8½-in.
Wire-Cut Lug Hillside	3½ x 4 x 8½-in.
Repressed Lug	3½ x 3½ x 8½-in.

There thus remain the following seven recognized types and sizes:

Plain Wire-Cut	3 x 4 x 8½ in.
"	3½ x 4 x 8½ in.
Repressed Lug	3½ x 4 x 8½ in.
Wire-Cut Lug	3½ x 4 x 8½ in.
"	3½ x 3½ x 8½ in.
"	3½ x 3 x 8½ in.
Repressed Hillside	3½ x 4 x 8½ in.

Objection was raised to calling these retained types and sizes "standards," since this is likely to be confused with the word as applied to technical standards which aim to define what, in the judgment of qualified experts, is a preferred design, process or procedure. As a result of the discussion the committee concluded to call the retained varieties "Recognized Types and Sizes."

The committee considered that with these four additional eliminations it had proceeded as far as was desirable until there were further reactions from consumers and producers with reference to elimination work. It was therefore concluded that no further eliminations should be considered until March 1923, at which time data of shipments for the year 1922 would be available and the opinions of producers and consumers could be canvassed.

N. Y. Highway Contractors War-Relief Act Unconstitutional

More than 300 claims by contractors seeking to recover approximately $4,000,000 from the State of New York for the difference between original contracts and the cost of work performed during the war are lost by a decision of the Court of Appeals declaring the Knight act unconstitutional.

Attorney-General Charles D. Newton conducted the case for the state. His argument, that the Knight law was unconstitutional, was based on a clause in the Constitution which says "the legislature shall not grant any extra compensation to any public officer, servant, agent or contractor."

In its decision the Court of Appeals likened the contracts involved in this case to other ordinary contracts, pointing out that "equity and justice recognizes the inviolability of contracts, protects and enforces the rights of parties thereunder, inhibits an unlawful abrogation of the same, awards damages arising from a breach thereof and likewise decree specific performance."

The court held that equity and justice do not require the state to reimburse the contractor for an increased expenditure incurred by him in the performance of a contract due in no measure to the act of the state.

"The state," the court said, "did not undertake to indemnify the claimant against loss upon his contract. On the contrary, it required him to give a bond for a strict compliance on his part with the terms of the same. War conditions and the increased cost of labor and materials, or scarcity of labor, were not precipitated by the state or due to any act upon its part."

The Knight act was a special act, passed in 1919 for the relief of highway contractors. The court decision has no reference to the Walters act of 1918, by which the state barge canal contractors and the New York subway contractors have been reimbursed for extra war costs.

May Provide Funds for Snow Removal From Highways

New York County boards of supervisors are authorized to appropriate money for the removal of snow from highways under a bill passed by the New York Legislature and approved by the Governor.

Municipal Home-Rule Bill Passed by New York Legislature

A bill providing for a referendum vote on an amendment to the New York State Constitution passed the New York Legislature March 17. If re-enacted next year the amendment will go to the electorate in November, 1923.

Endorse Coleman for Presidency of Am. Soc. C. E.

John F. Coleman, of New Orleans, was endorsed as a candidate for the presidency of the American Society of Civil Engineers at a recent meeting of the Louisiana section of the society. It is understood that similar action has been taken by local sections in Texas, St. Louis and Buffalo. Mr. Coleman's supporters point out that the only president of the American Society of Civil Engineers ever elected from the far South was Major B. M. Harrod, who took office in 1897.

Tennessee Bridge Site Approved

The location for a bridge across the Cumberland River near Clarksville, Tenn., submitted by the Tennessee State Highway Department, has been approved by the U. S. Bureau of Public Roads. This bridge will be located about 1½ miles up the Cumberland River from Clarksville.

The design submitted by the state highway department calls for the construction of two 280-ft. steel spans, one 180-ft. steel span, eleven 48-ft. and two 24-ft. reinforced concrete-girder-approach spans.

The cost of this structure, for which bids will be advertised as soon as this design is approved by the bureau, will be about $300,000 and will be borne by Montgomery County, the State of Tennessee, and the federal government.

Army Would Enroll Former Enlisted Men as Reserve Officers

In order that the army may be enabled to avail itself of the services of the many engineers who served as enlisted men during the World War, the Chief of Engineers has announced that the War Department will commission such men in the engineer section of the Officers Reserve Corps, provided they have the technical qualifications to warrant their appointment.

Under this policy, these men can be enrolled in the higher grades without affecting in any degree the appointment as second lieutenants of the young and inexperienced graduates of the R.O.T.C. units of the universities; and in considering the applications of enlisted men for commissions in the Reserve Corps the examining board will exercise a wide discretion and will give great weight to professional and technical ability rather than to a detailed knowledge of military regulations. Officers so appointed will be given an opportunity to receive the necessary instruction in military subjects before they are called upon for actual service in their grades or before they are eligible for promotion to the next higher grade.

Detailed information may be had by writing to the Chief of Engineers, Washington, D. C., or to the corps engineer at the headquarters of any of the mine corps areas into which the country is divided.

May Name Engineer as Director of Indiana Highways

Governor McCray of Indiana is reported to be considering the selection of a successor to Lawrence Lyons, director of the Indiana State Highway Department, who is expected to resign in a few weeks. A report is current that an engineer is to receive more consideration than a politician.

Mr. Lyons has said that he probably will not resign on April 1, as has been reported, but will undoubtedly be out of office before the summer begins.

Paint-Labeling Bill Before Congress

Ingredients of all paints and varnishes handled in interstate commerce must be listed on the container, under a Congressional bill of Senator Ladd, of North Dakota, who was influential in enacting a pure-paint law in North Dakota. The latter law in effect now for twelve years, has according to Senator Ladd proved a boon to the public and to paint manufacturers. He expects to secure the co-operation of manufacturers of paints and varnishes in promoting similar federal legislation.

Jersey Central Bridge Project Further Delayed

By rejecting plans presented by the Central Railroad of New Jersey for a new bridge across Newark Bay between Bayonne and Elizabethport, the State Board of Commerce and Navigation on March 20 further delayed the replacement of the present bay crossing. The matter is in the hands of the board because the War Department, whose approval of plans for the new bridge is required by the Congressional act authorizing its construction, has made its action contingent on prior approval by the New Jersey board. Questions of clearance height (as between 20 and 35 ft.) and width of channel through the draw are among the points of contention.

Indianapolis Studies Zoning and Major Street Plan

Studies for zoning ordinance for a major street plan for Indianapolis are being made for the Indianapolis City Plan Commission. The engineering work of the commission is in direct charge of Lawrence V. Sheridan, executive secretary of the commission. Robert H. Whitten, of Cleveland, is consultant for the City Plan Commission—instead of being consulting engineer, as was stated in *Engineering News-Record*, Feb. 16, p. 295.

Long-Span Bridge for Alaska

The Alaskan Engineering Commission has called for bids for the construction of the Nenana bridge on the Alaska railroad. The bridge, which will be ready for service March 1, 1923, will practically mark the completion of the line to Fairbanks. At present the railroad beyond the Nenana River is being operated as a narrow-gauge line, but standard-gauge ties have been placed, ready for setting the rail over as soon as the bridge is completed. The new structure is of particular interest since it will have a 700-ft. truss span, built in large part of special steel.

Am. Soc. C. E. Convention at Portsmouth

The American Society of Civil Engineers will hold its annual convention at the Hotel Wentworth, Portsmouth, N. H., June 21 and 22.

Brick Association Elects Officers

The National Paving Brick Manufacturers' Association, at its recent meeting, re-elected the following officers for the year 1922: Chairman of the board, S. M. Duty, Cleveland; president, O. W. Renkert, Canton; vice-presidents, W. M. Lasley, Chattanooga, and W. P. Blair, Cleveland; treasurer, C. C. Barr, Streator, Ill.; secretary, M. B. Greenough, Cleveland.

Vehicle Tunnel Contracts Awarded at $19,331,723

Booth & Flinn. Ltd., were awarded the contracts for the construction of the Hudson River vehicular tunnel at a meeting of the New York and New Jersey tunnel commissions in New York City, March 28. At the prices submitted the cost will be $19,331,723. The work, in addition to land and river shafts, involves the construction in compressed air of twin tubes of cast-iron, 29½ ft. in outside diameter, to be lined with concrete. The action of the two commissions follows the recommendation of Clifford M. Holland, chief engineer.

Concrete Road-Roller Patent Upheld by Court

The U. S. Circuit Court of Appeals, Fifth Circuit, at New Orleans, Feb. 24, upheld the Macon Concrete Road Roller Co.'s patent No. 1,253,022 for its process and device for finishing concrete pavements. The District Court had previously held valid and infringed claims 5 and 6 of the Ashmore and Morgan patent. The Court of Appeals reached the conclusion that the lower court did not err in its decision, rendered March 2, 1921, holding the patent valid.

The Macon Concrete Roller Co. of Macon, Ga., has issued a notice to infringers of the Ashmore and Morgan patent and process, granted July 16, 1918, that every means will be taken to protect the company's patent rights and to collect damages for unauthorized use.

Charge Limestone Combine

Suit was filed in the Superior Court, Indianapolis, March 24, by Attorney General U. S. Lesh, charging the existence in Indiana of an unlawful combination of companies controlling the quarrying and sale of Indiana limestone. The suit asks for a permanent injunction preventing a continuance of the alleged "combination and conspiracy" that the corporate charters and franchises of the accused companies be revoked, and for the appointment of receivers to wind up their affairs. Nineteen defendants, one of which is the alleged organization to which the quarries and selling agencies belong, are named in the suit. It is charged that the Bedford Stone Club Auxiliary, Inc., is the controlling organization.

Federal-Aid Road Legislation Moves Forward

(Washington Correspondence)

A long step toward securing definite appropriations for federal-aid highway construction during the next three years was taken when the Senate on March 20 passed the Post Office Appropriation bill, which had been amended so as to carry $50,000,000 for federal-aid roads during the next fiscal year; $65,000,000 for the year to end June 30, 1924, and $75,000,000 for the year to end June 30, 1925. In addition the bill carries $7,500,000 for forest roads and trails during the year to end June 30, 1924, and an equal amount for the year to end June 30, 1925.

The amounts approved by the Senate are the same as those carried in the Woodruff bill, with the exception that the Woodruff bill provides $6,500,000 for forest roads for the year to end June 30, 1924. The Woodruff bill is the subject of hearings before the committee on roads of the House of Representatives. It is believed that the majority of this committee will vote to report out that bill. It will be necessary to bring up the Woodruff bill in the regular manner, as the chances are against the House accepting the Senate amendment to the appropriation bill. Under the rules of the House the Senate amendment is subject to a point of order.

The advantage which comes to the legislation as a result of the Senate's action is that the upper chamber has gone on record, without a single voice being raised in opposition, to the three-year program and to the appropriations likely to be passed by the House.

Indiana Seeks Cement Bids

The Indiana Highway Commission will open bids on from 75,000 to 150,000 bbl. of cement, April 5. In these bids it is required that the companies submit a mill-base price, exclusive of sack rebate, freight rates and cash-discount figures. Highway officials said that bids on approximately 200,000 bbl. of cement received last week from eight companies were still under consideration, but it is understood that the results of the competition were not satisfactory, due to the fact that the bids were made without quoting a mill-base price. An examination showed that some of the bids were based on a $1.60 mill-base price, one on a $1.54 and one on $1.68, as compared with the $1.30 mill-base price quoted in February by the Marquette Cement Co.

New Federal-Aid Highway Bills

Washington Correspondence

Additional federal-aid highway bills have been introduced in the House by Representatives Doughton, N. C., and Robsion, Ky. Mr. Doughton proposes that for the fiscal year ending June 30, 1923, there shall be appropriated $100,000,000, and a like sum for the years to end June 30, 1924, and June 30, 1925. For forest roads and trails he proposes that $2,500,000 shall be appropriated for each of the years ending June 30, 1924, and June 30, 1925.

The Robsion bill contemplates the expenditure of $75,000,000 for the fiscal years of 1923 and 1924 and $100,000,000 for 1925 under the general provisions of the highway act and $5,000,000 each for 1924 and 1925 under Section 23.

Dr. Merriman To Be Guest of New York Lehigh Club

A dinner in honor of Dr. Mansfield Merriman, editor of the American Civil Engineers' Handbook, author of numerous engineering books, and former professor of civil engineering at Lehigh University, is to be given by the New York Alumni of that institution at the Aldine Club, New York City, April 18.

John R. Freeman, George H. Pegram, Robert Ridgway, Prof. Henry S. Jacoby, Prof. Frank P. McKibben and Prof. Ralph J. Fogg will be the speakers and many of the other associates of Dr. Merriman will attend the dinner.

Long-Service Water Meters at Rochester, N. Y.

In the news item on the recent meeting of he New York Section of the American Water Works Association, printed in the March 9 issue, p. 418, the statement that "Mr. Little remarked that a water meter sold to Rochester 32 years ago by the late John C. Tully, was still in use," should have read: "Several meters purchased 42 years ago from John C. Kelly were still in commission."

Concrete Restored in Indianapolis

Concrete is back on the records of the Board of Public Works of Indianapolis as one of the five materials on which bids will be received for the permanent improvement of streets and alleys in Indianapolis. The board restored concrete after having ousted it by resolution on March 1. The action was looked upon as a victory for John L. Elliott, city engineer, in his fight for lower paving costs.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Spring Society Meeting, Dayton, Ohio, April 5-6; Subject, "Flood Problems."

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 9-11.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Salt Lake City, Utah, June 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Portsmouth, N. H., June 21-22.

The Pueblo Engineers Association held its annual meeting Jan. 25 and elected the following officers; President, H. K. Barton; vice-president, D. J. Cox; secretary-treasurer, W. B. Curry.

The Swedish Engineer's Society of Chicago held its annual meeting Jan. 28, at which the following officers were elected: President, John S. Gullborg; vice-president, A. Monson; financial secretary, C. J. Gustafson; treasurer, C. Hallbom; secretary, A. Cederoth.

The Jacksonville Chapter, A. A. E. elected the following officers at its recent annual meeting: President, George W. Simmons, Jr.; vice-presidents James A. Hammack and C. S. Hammatt; secretary A. C. Newman.

Tri-state Water and Light Association of the Carolinas and Georgia will hold its annual convention in Spartanburg, S. C., April 19-21. F. B. McDowell, Jr., assistant manager and engineer, Commissioners of Public Works, Charleston, S. C., will speak on the new 14,000,000-gal. concrete filter plant of the Charleston water department. C. W. Grantham, superintendent of water-works, Greensboro, N. C., will talk upon metering public water supplies. Representatives of the board of health from each state will deliver addresses on what their respective states are doing to protect the public water supplies and streams. Other papers of interest are planned for the various sessions.

Personal Notes

BURTON L. WINSLOW, who for 18 years was in the engineering department of Brockton, Mass., and was subsequently division engineer for the Bureau of Water-Works Improvement, Akron, Ohio, has been appointed town-manager of Stoughton, Mass.

H. W. SMITH, formerly plant engineer in charge of reconstruction and operation for the Great Western Portland Cement Co., Mildred, Kan., has been appointed street commissioner of Evanston, Ill.

F. C. BRUSH, Westfield, N. J., has been appointed city engineer of Norwich, N. Y.

PAUL S. JONES has been appointed superintendent of Imperial Mutual Water Co. No. 1, in Imperial Valley, Cal. He is a graduate of the engineering department of the University of California, and for a time was connected with the California Debris Commission in the San Joaquin and Sacramento valleys. In his new position he will have charge of all engineering work for the water company.

M. P. TUCKER, formerly chief engineer of the Firestone Tire and Rubber Co., has been appointed superintendent of the Akron, Ohio water-works.

H. B. BELFORD, formerly deputy county engineer, Wayne County, Wooster, Ohio, has been made resident engineer for the Illinois Highway Department with headquarters at Carbondale, Ill.

SAMUEL HART has been appointed deputy city engineer of Sacramento, Cal.

ARTHUR P. DENTON, for the past two years district engineer for the Portland Cement Association at San Francisco, has resigned to accept the position of sales manager for the Pacific Portland Cement Co. of San Francisco.

O. C. TRETTEN, for the past two years field engineer for the Portland Cement Association, with headquarters at Sacramento, Cal., has been appointed acting district engineer for that association with headquarters at San Francisco.

WALTER BARBER, who has been city purchasing agent for Long Beach, Cal., has been appointed assistant city manager. Mr. Barber was county engineer of Osceola County, Iowa, 1907-1910, and of Clay County, in the same state, 1910-1918.

ALBERT E. LAVERY, vice-president of the Bridgeport Hydraulic Co., Bridgeport, Conn., was elected treasurer of the company recently to fill the vacancy caused by the death of Walter S. Wilmot, who had been treasurer for many years.

RUDOLPH F. SCHAEFER, Richmond Hill, N. Y., DAVID ROBERTSON, Boonton, N. J., and HERBERT F. BUTLER, New Rochelle, N. Y., have been appointed assistant engineers with the New York-New Jersey Tunnel Commission.

HOLTON COOK, resident engineer, for the Department of State Roads and Highways of Kentucky, has been made assistant division engineer and transferred from Smithland to Ashland.

LOUIS P. SMITHEY and MATTHEWS H. TARDY, have opened an office in Roanoke, Va., for the practice of architecture and engineering. Both served in the World War, prior to which Mr. Smithey was contracting engineer for the Virginia Bridge & Iron Co., and Mr. Tardy was with the Du Pont Co., at Wilmington, Del.

J. H. MANNING has succeeded Col. Peter Junkersfeld as engineering manager of Stone & Webster. Col. Junkersfeld's retirement to enter the firm of Junkersfeld & McClellan was noted in these columns some weeks ago. Mr. Manning has been with Stone & Webster since 1910, prior to that time having been an assistant of Col. H. L. Cooper. He was superintendent of construction of a number of the western hydro-electric projects. During the war he was chief engineer and manager of the construction activities at Hog Island, and on his return to Boston became assistant engineering manager of Stone & Webster.

COL. GEORGE L. WATSON, consulting engineer, will collaborate with the George A. Johnson Co., consulting engineers of New York City, instead of incorporating his practice with that of the Johnson organization as announced in this journal, March 16, p. 465. Col. Watson has moved his office to the same address as that of the Johnson Company. In addition to serving his personal clientele Col. Watson will work with the Johnson Company on matters relating to surveys, reports, designs and supervision of construction of water works, water purification plants, sewerage systems, sewage disposal plants, refuse disposal stations, power developments and numerous other branches of civil, electrical and mechanical engineering. Col. Watson's experience covers a wide field in mining, tunnel, bridge, harbor improvement, pipe-line and sewerage work in the United States; and service with the British and American armies in Europe during the World War. He is a member of the board of consulting engineers to the New York State Bridge & Tunnel Commission and the New Jersey Interstate Bridge & Tunnel Commission.

T. J. IRVING has been promoted from assistant engineer of the Iowa division to division engineer on the Minnesota division of the Chicago & Northwestern Ry., with offices at Winona, Minn. He succeeds the late W. J. Jackson.

C. H. WELLS has been appointed assistant engineer on the Iowa division of the Chicago & Northwestern Ry. at Boone, Ia., to succeed T. J. Irving, promoted to the Minnesota division.

BUSINESS NOTES

FRANK A. FURST, who recently resigned as president of the Arundel Corp., has been elected chairman of the board of directors. JOSEPH J. HOCK, vice-president of the corporation, has been made its president.

F. E. WELSH, general superintendent of the Fred R. Jones Co., contractors, Chicago, Ill., has resigned to enter the contracting field with his own organization.

C. E. SKINNER, who has been with the Westinghouse Electric and Manufacturing Co. in various capacities since his graduation from Ohio State University in 1890, has recently been appointed assistant director of engineering, with headquarters at East Pittsburgh, Pa.

THE DOULLUT & WILLIAMS Co., Inc., engineers and general contractors of New Orleans, La., announces the reorganization, consolidation and incorporation of the following companies under the above title: Doullut & Williams, Inc., Southern Lighterage & Wrecking Co., Inc., Shell Beach Land & Improvement Co., Inc. The new company will carry on the work previously handled by the above named companies and will extend its operations to provide for various kinds of construction with a department for each class of work under the management of an engineer skilled in the work of his particular department.

OBITUARY

CORNELIUS DONOVAN, civil engineer formerly on duty with the Corps of Engineers, died recently in New Orleans at the age of 73. He was born in Ann Arbor, Mich., and was a graduate of the University of Michigan. For many years he had supervisory control over the jetties through the South Pass on the Mississippi River which he had helped to construct under James B. Eads. Mr. Donovan retired from active government service in 1916 because of ill health.

CLARENCE E. SPRAGUE, assistant engineer at the Trenton plant of the American Bridge Co., died suddenly March 16. He had been with the American Bridge Co., and with its predecessor the New Jersey Steel & Iron Co., since 1895.

CLARENCE E. STUBBS, 42 years old, building inspector of Baltimore, Md., from 1911 until 1915 and later engaged in the contracting business in that city, died on March 21 at Denver, Col.

EQUIPMENT AND MATERIALS

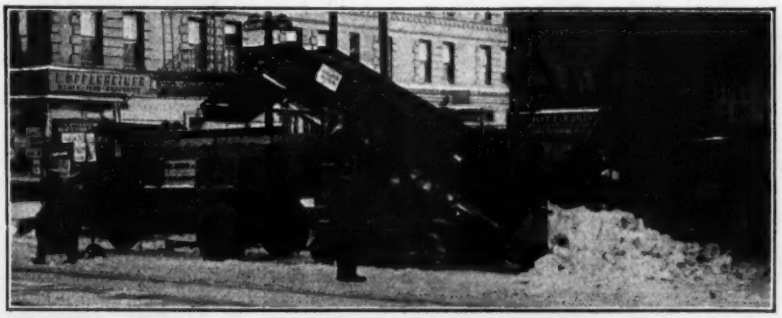
Adapt Loader for Snow Removal

To adapt its mechanical truck loader to snow-removal work the George Haiss Manufacturing Co., of New York, during last February's storm in New York City, operated a machine on which a pan conveyor was substituted for the standard bucket conveyor. Other mechanical changes included the lengthening and widening of the elevator frame, a 20-per cent increase in all speeds, and a decrease in the inclination of the elevator frame.

The endless pan conveyor consisted of a series of overlapping steel plates carried by two parallel roller chains, with angle cleats spaced 12 in. on an elevator shaft 20 ft. long, inclined at 30 deg. to the horizontal. On each side of the extended tail shaft are steel feeding propellers cleaning out a path about a foot wider than the machine. The elevator frame is pivoted at the center, to give it low clearance when moving, where it is carried by A-frames on a structural steel chassis carrying the engine and transmission parts, which, in turn, are supported on creeper treads.

The conveyor speed is 175 ft. a minute, the forward speed 100 ft. and reverse 50 ft.

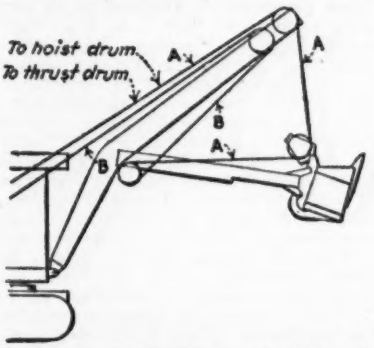
This snow loader, according to the observations of its manufacturer, operating in piles of snow, averaged 2 min. 10 sec. per truck rated at 7.7. cu.yd. The piles handled were so stiff that when the loader was backed into them they slid so that it was necessary to use hand labor to break the piles down as the machine backed into them. On this operation there were required one loader operator and three or four laborers breaking down the piles. Ordinarily the operator and one laborer would handle everything.



New Gasoline Shovel Can Shake Bucket

Transmission of gas-engine power to the thrust of a revolving shovel without an excessively complicated design, so as to give the machine the powerful thrust and quick reversals of a steam shovel are the characteristics of the new 1-yd. gasoline shovel recently put out by the Bucyrus Co., South Milwaukee, Wis.

Power is derived from a single, heavy, slow speed, 55-hp. four-cylinder engine which transmits it through four clutches. By means of a small drum mounted on the shipper-shaft all motions of the dipper are controlled, thus eliminating the usual complication entailing chains, bevel gears, belts or telescopic shafting. A dry-type, asbestos-lined disk clutch, engaging or disengaging the entire machinery, connects the engine crank shaft to the transmission. The thrust and hoist-drums run loose on the same shaft. The hoisting clutch is operated by an independent thrust-cylinder and the



thrusting clutch by a hand-toggle mechanism. Propelling is accomplished by a positive spur-and-bevel-gear drive direct from the engine. The swinging mechanism consists of a spur-and-bevel-gear drive direct from the engine and the two cone clutches for reversing the motion.

The thrusting motion on the dipper handle is accomplished by means of a small drum, keyed to the shipper shaft. On this drum are anchored ropes *A* and *B* (see sketch), *A* running to the hoisting drum, which runs loose on the shaft and *B* to the thrusting drum also running loose on the same shaft. Thrusting out is accomplished by a pull on rope *A*, thrusting in by a pull on rope *B*. Hoisting is accomplished by setting the brake on the thrust drum which makes all the motion go into hoisting. If the brake is partly released, the resulting motion will be combined thrusting and hoisting. If it is entirely released all motion will go into thrusting and if fully applied, hoisting will result. Shaking the dipper can thus be effected.

Specification data are as follows: Length of boom, 25 ft., 9 in.; handle, 14 ft.; traction speed, 0.4 miles per hour; width on caterpillars, 10½ ft.; working weight on caterpillars, 47 tons; fuel consumption 4½ to 5½ gal. per hour. The machine may be equipped as a drag-line excavator, a crane or a clamshell excavator with simple changes made in the field. It is mounted on crawler tractions, traction wheels or railroad trucks.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Large Contracts Let

Among this week's announcements of contracts awarded in Construction News, pp. 137@150 are the following large projects: A 12-story bank and office building at Boston, to I. G. Harsey & Sons, 75 Wareham St., $1,000,000; four 8-story apartments and a 6-story office building at Pittsburgh, to Hegeman & Harris, 185 Madison Ave., New York City, $1,400,000 and $500,000 respectively; superstructure of Porter St. pier, Philadelphia, to F. H. Harris & Co., 1520 Parrish St., $1,250,000; an 11-story clubhouse at Indianapolis, Ind., to Bedford, Stone & Construction Co., 810 Fletcher Trust Bldg., $1,000,000; a hotel at Grand Rapids, Mich., to Owen-Ames-Kimbal Co., 42 Pearl St., $1,000,000; a hotel at Los Angeles, to Scofield Engineering Construction Co., Pacific Finance Bldg., $5,086,000; shaft caissons and tunnels between New York and New Jersey to Booth & Flinn, Ltd., 17 Battery Pl., New York City, $19,331,723.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 137@150 are the following:

A high school at Hartford, Conn., $1,000,000.

An apartment at Chicago, Ill., $2,000,000.

An office building at Chicago, Ill., $1,500,000.

Materials and Labor Prices in Four Canadian Cities

Montreal to Vancouver—Rapid Comparison with United States Quotations—Canadian Dollar About 97 Cents

These Canadian quotations were collected by *Engineering News-Record's* Construction News correspondents as of the following dates: Montreal, March 18; Ottawa, March 15; Winnipeg, March 14; Vancouver, March 3. The Canadian dollar is now rated at about 97 cents, exchange value, which allows a comparison to be drawn between prices in Canada and the United States. Further reductions of materials prices in Canada will depend largely upon the action of the new Dominion administration in regard to freight rates.

Wage rates quoted in Winnipeg will remain effective until April 30, 1922, at which time changes, on a reduced basis, are anticipated. The construction outlook in Canada is very optimistic, particularly in Ottawa where agreements have been entered into between the employers and the bricklayers, carpenters, hodcarries and common laborers to maintain the wage scale, as of March 18, 1922, in effect until May 1, 1923. The present wage rates, however, paid hoisting engineers and structural ironworkers will not remain in effect after May 1, 1922. Although union common laborers are paid 45c. in Ottawa, non-union comon laborers are employed at 30c. per hour on county and provincial road work.

Winnipeg — Gravel obtained from local pits is quoted at $1.90 per cu.yd., f.o.b., for 1½ in.; $2.25 in dealers' yards for ¾-in. Sand is delivered on job at $3.15 per cu.yd. Crushed stone, 1½-in. to 2-in., is quoted at $3.75 per cu.yd. delivered; $2.85 at yards; $2.45 f.o.b. cars and at $1.55 f.o.b. quarry. Size ¾-in. costs $4 delivered; $3.10 at yards; $2.75 f.o.b. cars and $1.90 f.o.b. quarry. Quarries are located at Stonewall, Manitoba, about 20 mi. from Winnipeg. No paving stone, brick paving blocks or wood-blocks are used in this city and no asphalt is obtainable. Commercial cement (natural) is quoted at $3.20 delivered; $3 at yards and $2.64 per bbl. f.o.b. cars, exclusive of bags. Hydrated lime is handled in 50-lb. paper and jute bags. American fire bricks are quoted in Winnipeg at $100 per 1,000 delivered; $95 at yards and $90 f.o.b. cars, in city. Canadian fire bricks are quoted at $85 delivered; $80 at yards and $75 per 1,000 f.o.b. cars. Chimney bricks are

PRICES OF PRINCIPAL MATERIALS AND RATES OF LABOR IN FOUR CANADIAN CENTERS

	Vancouver	Montreal	Ottawa	Winnipeg
Sewer pipe—carlots, per ft.				
4-in.	$0.20	$0.30	$0.21	$0.35
6-in.	.30	.45	.32	.45
8-in.	.35	.70	.60	.60
12-in.	.65	1.35	.95	1.00
24-in.	2.40	4.50	3.15	.....
36-in.	.....	6.50	.....	.....
Asphalt—carlots, in packages, per ton	.....	28.00	31.18	.....
carlots, in bulk, per ton	.....	21.00	24.90	.....
Paving stone—per sq.yd.	.....	125.00 per M.	3.65	.....
Wood-blocks—16-lb. treatment, per sq.yd.	.....	4.50	4.15	.....
Sand—cargo or cars, per cu.yd.	2.75 (del.)	1.50 per ton	2.50 (del.)	3.15 (del.)
Gravel—cargo or cars, 1½-in. per cu.yd.	2.75 (del.)	1.25 per ton	.....	1.90 f.o.b. cars
¾-in. per cu.yd.	2.75 (del.)	1.50 per ton	.....	2.25 at dealers yards
Crushed stone—cargo or cars, 1½-in. per cu.yd.	4.00	2.00 per ton	2.07@2.19	2.45
¾-in. per cu.yd.	4.00	2.10 per ton	2.68@2.80	2.75
Cement—carlots, without bags, per bbl. natural—500 lb. and over	.....	.....	.....	2.64
portland—f.o.b.	3.35	2.40	3.75	2.90
portland—delivered	3.45	.....	.....	.....
Lime—warehouse prices, including cloth bag				
hydrated—finishing, per ton	25.00	26.00	35.00	24.00 in paper bags
hydrated—common, per ton	.....	21.00	.....	.....
lump—finishing, per 180-lb. bbl. (net)	2.60	15.00 per ton	.....	.....
lump—common, per 280-lb. bbl. (net)	.....	11.00 per ton	19.00 per ton	3.20
Brick—cargo or carlots, per 1,000, common	25.00	16.00	25.00	19.00
paving block—3½x8½x3	60.00	.....	3.65 per sq.yd.	.....
3½x8½x4	60.00	.....	.....	.....
Hollow wall tile—carlots, per block—4x12x12	.12	.20	.11	.085
8x12x12	.25	.30	.22	.12
Lumber—wholesale, carlots, to dealers, f.o.b. No. 1 grade, per M. ft. b.m.				
1-in. rough, 10-in. x 16 ft. and under, pine	.....	.....	85.00	76.50
fir	16.00	48.00	83.00	31.50
hemlock	16.00	35.00	30.00	34.20
2-in. tongue and groove, matched, 10-in. x 16 ft. and under, pine	.....	.....	70.00	.....
fir	.....	45.00	56.00	35.50
8-in. x 8-in. x 20 ft. and under, pine	.....	.....	75.00	.....
fir	18.00	47.00	75.00	36.00
hemlock	.....	35.00	45.00	37.00
spruce	.....	35.00	60.00	37.00
12-in. x 12-in. x 20 ft. and under, pine	.....	.....	85.00	.....
fir	10.00	47.00	85.00	36.00
Manila rope—¾-in. and larger, 1200-ft. coils, per lb.	.19	.30	.52	.235
Explosives—small lots, delivered, 40 per cent gelatin, per lb.	.....	.21½	.213	.287
60 per cent gelatin, per lb.	.....	.25½	.227	.327
Labor rates per hour, bricklayers	1.06¼	.80	.85	1.15 (44 hr. week)
carpenters	81¼	.60	.70	.90 (44 hr. week)
hoisting engineers	.90	.50	.75	.90@1.10 (50 hr. week)
hod carriers	.62½@.75	.30	.45	.....
pile drivers	81¼	.50	.....	.....
structural iron workers	1.12½	.50	.72½	1.10 (44 hr. week)
common labor union	.....	.....	.45	.47½@.55 (50 hr. week)
common labor non-union	.45 @.50	.20@.30	.30	.35

quoted at $25@$30 per 1,000. Douglas fir is the principal lumber and is shipped direct from mills in British Columbia. Bricklayers, carpenters and structural ironworkers operate on the 44-hr. basis; hoisting engineers and union common laborers work 50 hr. per week.

Ottawa—Common bricks are quoted at $25 both in Ottawa and Vancouver as against $19 in Winnipeg. Sewer pipe, 4-in., is quoted at 20c. in Vancouver; 21c. in Ottawa; 35c. in Winnipeg. Sand is quoted in Ottawa at $2.50 as against $2.75 per cu.yd. delivered in Vancouver. Dynamite, 40 per cent gelatin, costs 21.3c. in Ottawa as compared with 28.7c. per lb. in Winnipeg.

Vancouver—Structural steel is quoted at $150 per ton in comparatively small quantities; reinforcing steel in less than carload lots at $4 per 100 lb.; manila rope, ¾-in. costs 19c. Wage rates in the building trades are: Cement finishers, $5.50@$6; electricians, lathers and plumbers, $8; electricians' helpers, $5; glaziers, $4.80@$5.20; painters, $6; roofers and sheetmetal workers, $7.20.

PRICES IN UNITED STATES AND CANADA

Construction materials prices in Vancouver as compared with those prevailing in Seattle show 8-in. sewer pipe, for instance, at 35c. in the former city and 36c. per ft. in the latter. Other materials, however, do not compare so closely. Hydrated finishing lime is quoted at $2 per ton, lump finishing lime at 40c. per bbl. and 8-in.@12-in. Douglas fir lumber at $2 per M. ft., higher in Seattle.

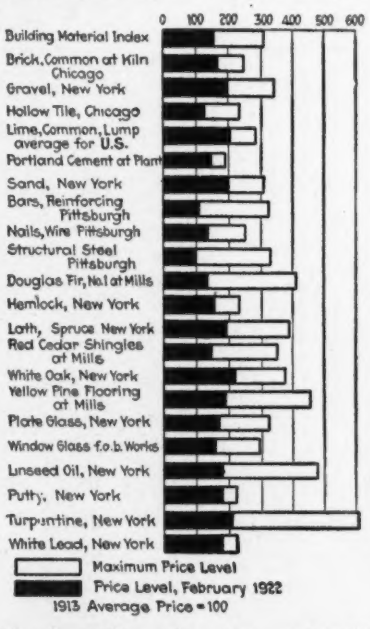
Piledrivers receive 18¾c. and structural ironworkers 22½c. more per hr. in Seattle than in the Canadian city, but bricklayers receive 6¼c. and carpenters 1¼c. more per hr. in Vancouver than in Seattle. Scales for hoisting engineers, hodcarriers and common laborers are the same in both cities.

Materials prices are evidently slightly higher in Winnipeg than in Minneapolis. Sewer pipe, 8-in., is quoted at 20c. per ft., gravel at 40c. per cu.yd., crushed stone 45c.@50c. per cu.yd., cement 66c. per bbl., brick $4 per M., hollow tile 2c. per block, 2-in. fir at 75c. per M. ft., manila rope at 4c. per lb., and dynamite at 6c.@7c. per lb., higher in Winnipeg than in Minneapolis. Hydrated finishing lime is quoted at $5 per ton, Douglas fir lumber at $4 per M. ft. and 8-in. hemlock at $1 per M. ft., higher in Minneapolis than in Winnipeg. Hemlock lumber, 1-in., is quoted at the same price in both cities but 1-in. yellow pine is twice as high in Winnipeg as in Minneapolis. Wage rates in the building trades are higher in the Canadian city in question, as bricklayers receive 15c., carpenters and hoisting engineers, 10c., and ironworkers 30c. per hr. more in Winnipeg than in Minneapolis. Non-union common laborers, however, receive 5c. more per hour in Minneapolis than in Winnipeg.

Building Materials Prices—Now and at Peak

(Bureau of Labor Statistics Figures)

The building material index of the Bureau of Labor Statistics was 158.7 for February, as just reported, against 159.9 in January, and 304.6 at the peak (April, 1920). The chart and table show both this index and the indexes of the twenty-two materials which comprise it. Four materials are given as more than 100 per cent higher than in 1913: Lump lime, sand, white oak and turpentine. Cement at the plant is 48.4 per cent above the 1913 level. Structural steel is reported 99.3 compared with 100 in 1913 and 331 at the peak.


0 100 200 300 400 500 600
Building Material Index
Brick, Common at Kiln Chicago
Gravel, New York
Hollow Tile, Chicago
Lime, Common, Lump average for U.S.
Portland Cement at Plant
Sand, New York
Bars, Reinforcing Pittsburgh
Nails, Wire Pittsburgh
Structural Steel Pittsburgh
Douglas Fir, No. 1 at Mills
Hemlock, New York
Lath, Spruce New York
Red Cedar Shingles at Mills
White Oak, New York
Yellow Pine Flooring at Mills
Plate Glass, New York
Window Glass f.o.b. Works
Linseed Oil, New York
Putty, New York
Turpentine, New York
White Lead, New York
Maximum Price Level
Price Level, February 1922
1913 Average Price = 100

BUILDING MATERIALS INDEXES OF BUREAU OF LABOR STATISTICS

Commodity	At Peak — Date	At Peak — Index	Index Numbers — Dec. 1921 Index	Jan. 1922 Index	Feb. 1922 Index
Building material index*	Apr. 1920	304.6	160.8	159.9	158.7
Brick, common, at kiln, Chicago	Oct. 1920	251.1	180.8	170.1	169.7
Gravel, New York	June 1920	340.4	198.6	198.6	198.6
Hollow tile, Chicago	June 1920	236.9	108.0	128.3	128.3
Lime, common, lump, average for U. S.	Oct. 1920	286.0	211.0	207.8	206.8
Portland cement, at plant	Sept. 1920	192.9	148.4	148.4	148.4
Sand, New York	May 1920	302.5	201.7	201.7	201.7
Bars, reinforcing, Pittsburgh	July 1917	327.1	109.0	109.0	109.0
Nails, wire, Pittsburgh	Jan. 1920	252.9	153.3	143.0	136.1
Structural steel, Pittsburgh	June 1917	331.0	99.3	99.3	99.3
Douglas fir, No. 1 at mills	Jan. 1920	407.3	124.9	124.9	135.8
Hemlock, New York	Feb. 1920	235.3	153.8	153.8	153.8
Lath, spruce, New York	Jan. 1920	396.8	207.2	192.6	192.6
Red cedar shingles, at mills	Feb. 1920	346.8	148.5	152.0	148.0
White oak, New York	Mar. 1920	379.6	224.5	224.5	216.2
Yellow pine flooring, at mills	Feb. 1920	455.3	189.1	181.9	189.0
Plate glass, New York	Aug. 1920	329.5	169.0	169.0	169.0
Window glass, f.o.b. works	Aug. 1918	295.2	231.0	192.5	154.0
Linseed oil, New York	Aug. 1919	480.4	145.9	155.8	176.9
Putty, New York	Jan. 1920	226.4	179.2	179.2	179.2
Turpentine, New York	Apr. 1920	601.8	190.2	212.4	210.9
White lead, New York	Mar. 1920	229.3	181.2	181.2	181.2

*Copper wire, sheet copper, lead pipe and sheet zinc have been added to the group making up the building material index, which makes a slight change from the index previously published.

Detroit Receives Cement Bids

In response to advertisement for proposals for furnishing the City of Detroit with 75,000 bbls. of cement to be delivered as directed during the year ending Jan. 31, 1923, bids were received from the following companies:

	F.O.B. Shipping Point — Price per Bbl. —	F.O.B. Detroit
Wabash Portland Cement Co., Detroit, Mich., (works at Stroh, Ind.)		
Paper sacks	$1.76	$2.22
Cloth sacks	2.01	2.47
Universal Portland Cement Co., Chicago, Ill.		
Paper sacks	1.75	2.22
Cloth sacks	2.00	2.47
Bulk	1.55	2.02
Huron and Wyandotte Portland Cement Companies, Detroit, Mich., at Alpena;		
Paper sacks	1.72	2.22
Cloth sacks	1.97	2.47
Bulk	1.52	2.02
Wyandotte;		
Paper sacks	1.85	.....
Cloth sacks	2.10	.....
Bulk	1.65	.....

The commissioner of purchases and supplies recommended that contract be awarded to the Huron and Wyandotte Portland Cement Companies and the approval of the City Council was asked.

Proposals have been asked for the transportation of 75,000 bbls. of cement by truck from the cement plant at Wyandotte, Mich., to be delivered to any place within the limits of the city of Detroit as may be directed by the Department of Purchases and Supplies.

Cheaper Materials and Freights Lower Bidding in Ohio

(Columbus Correspondence)

Low bids on road work opened by the Ohio Department of Highways and Public Works since Jan. 1 have been almost 20 per cent below the estimates of the engineers in the department. The reason for this decline is an interesting study in costs and psychology. With the opening of bids about the middle of January, road contractors were anxious for work and they figured that much of the labor that is to be employed during the present season can be hired at greatly reduced prices. Little of the work has started yet and of course the exact wage that must be paid to unskilled labor is not known, but it will range between 25 and 35c. per hour, instead of 50 to 65c. per hour as during the peak of high wages.

Another important factor is the reduction in prices of road materials. Gravel, which formerly cost from 80 to 90c. per ton at the plant is now being bought for 60 to 70c. and sand is about 5c. less than gravel.

Cement is down from 15 to 25c. per bbl., while crushed stone is down about 25 to 35 per cent.

The greatest reduction has been made on brick which sold at $32@$33 in the middle of 1920 and now sells around $25. All of these prices are f.o.b. plants.

Another factor is the reduction in freight rates in Ohio on all road building materials which was ordered by the Ohio Utilities Commission on Oct. 20, 1921. This removed the last (40 per cent) increase in freight rates and was a reduction of 28 per cent. As freight enters into the cost of road building on the average of 13.5 per cent this reduction was decidedly important. These factors have aided in bringing about lower bids on state work.

Railroads Plan To Spend Millions

The Great Northern Railway Co. will spend about $800,000, according to its estimate, in construction of engine terminals in Northeast Minneapolis, together with some incidental grade separation there. Contract for the terminals has been let to A. Guthrie & Co., Inc., of St. Paul.

Included in this contract is the erection of a 30-stall brick roundhouse, a machine shop, turntable, cinder pit and coal facilities, while power and store houses will be erected later. The Great Northern is now building a $2,000,000 concrete and steel ore dock at Duluth, and has authorized 40 miles of second main-line track laying in Washington and North Dakota, as well as erection of a car-repair shop at Minot, N. D., together with certain trackage improvements there.

While rumors have been published that the Great Northern improvement budget for 1922 totals $17,000,000, President Ralph Budd is to make a definite statement about April 1.

At the office of the president of the Northern Pacific it is announced that the 1922 improvement budget, as approved, totals about $18,000,000 of which $4,000,000 represents items carried over from last year.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of March 2; the next on April 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	—$2.48	$3.35	$4.00	$2.63	$2.66	$3.50	$3.10	$3.25	$3.75
Structural rivets, 100 lb	—3.35	3.90	5.50	3.43	3.90	4.55	4.50	3.75	6.50
Reinforcing bars, ¾ in. and larger, 100 lb	—2.38	3.25	3.50	2.53	2.56	3.42½	2.75	3.25	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	68%	45%	59½%	61.9-5%	44%	58.8%	53%	35.10
Cast-iron pipe, 6in. and over, ton	47.30@48.30	40.00	48.30	43.10@44.60	+47.00	52.00	48.00	52.00	55.00
Concreting Material:									
Cement without bags, bbl	2.40	2.39	2.25	1.94	2.24	2.90	2.73	2.94	2.40
Gravel, ¾ in., cu.yd	1.75	1.85	2.25	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.00	1.15	2.25	2.00	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	49.00	37.00	—33.50	43.00	38.00	34.75	28.00	20.00	47.00
Lime, finishing, hydrated, ton	15.80@16.80	18.00	25.00	18.00	29.00	24.00	22.00	27.00	21.00
Lime common, lump, per bbl	2.75@3.48	1.25	2.50	1.40	1.40	2.70	1.75	2.75	11.00
Common brick, delivered, 1,000	19.40@19.90	8.75	11.15	11.00	15.00	12.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.07975	.115	.0821	.0752	.08	....	.10	—.08
Hollow partition tile 4x12x12, block	.11120	.06525	.115	.0657	....	.10	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal	—.83	+.89	.109	—.90	.93	1.08	1.04	.86	1.05
Common Labor:									
Common labor, union, hour	.60	.35	.....	.72½	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.....	.20	.25	.35@.40	.40@.50	.35@.40	.47½@.56	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump line per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net. Hollow building tile delivered.

Montreal quotes on fir instead of pine. Sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.70 cents). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

Steel shapes are quoted in the New York warehouses at $2.48 as against $2.63; structural rivets at $3.35, reduced from $3.50 and reinforcing bars at $2.38 as compared with $2.53 per 100 lb. one week ago. With prices declining in the warehouses, producers of shapes, plates and bars continue to quote $1.50 per 100 lb., Pittsburgh, but still seem unable to firmly establish the market on that basis. Actual buying is possible at $1.40@$1.45 f.o.b. mill. Cold rolled shafting is quoted in Minneapolis at $3.43 as against $3.68 per 100 lb. delivered; cast-iron pipe, 6-in., at $47 as compared with $46 per ton, last week.

Raw linseed oil is quoted at a reduction of 1c. in New York; 7c. in Chicago and at an advance of 8c. per gal. (5 bbl. lots) in Atlanta.

A total of 382 mills reporting to the National Lumber Manufacturers' Association for the week ending Mar. 18, show 180,944,123 ft. of lumber cut; 193,311,165 ft. shipped and orders for 203,325,892 ft. b.m. Production stands at 20 per cent; orders at 10.5 per cent and shipments at 17 per cent below normal.

Comparison of materials prices and building trades' labor rates in four representative Canadian centers with quotations in the principal markets of the United States, may be had by referring to the article on p. 548 in connection with the weekly construction market quoted above. Ottawa wage agreements effective until May 1, 1923